Vol. 12 FEBRUARY, 1929 No. 2

Journal
of the
American Ceramic Society

Abstracts
Vol. 8, No. 2

Bulletin
Vol. 8, No. 2

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 20th & Northampton Sts., Easton, Pa.

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: F. K. Pench, *Chairman;* W. E. Dornbach, F. C. Flint, M. L. Hartmann, Ross C. Purdy.

Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.

(*Copyright 1929, American Ceramic Society*)

Twelve dollars a year. Single numbers, one dollar. (*Foreign postage, 50c additional*)

Highest Grade Materials for Ceramic Purposes

Specialties for Pottery and Glass, Cast Iron and Sheet Iron Enameled Ware, Terra Cotta, Tiles, Bricks, and Clay Products

Alumina
Ammonia
Antimony
Arsenic, White
Barytes
Bismuth
Bitstone
Black Body
Blue-Green Oxide
Bone Ash
Boracic Acid, Refined
Boracic Acid, Tuscan Flaky
Borax Refined
Brimstone
Cadmium Sulphide
Calcium Carbonate
Chalk
Chrome Oxide Green
Chrome Yellow
Clays
Cobalt
Copper
Copperas
Cornwall Stone
Crocus Martis
Enamel Lack
Enamel Soda
Epsom Salts
Feldspar
Minpro Feldspar
Connecticut Feldspar
Flint
Fluorspar
Glass
Liquid Bright Gold
Colors
Iron
Kalkspar
Kaolin
Kryolith
Lead
Leukonin
Lime
Litharge
Magnesite
Magnesia Calcined
Magnesia Calcined, Heavy
Magnesia Chloride
Magnesia Carbonate, Pure, Light
Manganese Oxides
Manganese Recovered
Marble Dust
Mennige
Minium
Mica, Powdered
Nickel Oxide
Nickel Carbonate
Ochre Red
Ochre Yellow
Opal Composition
Paris Whites
Pearl Ash
Pebbles
Plaster Paris
Porcelain Balls
Potash Carbonate
Potash Nitrate
Potash Bichromate
Powdered Blue
Purple Cassius
Putty Powder
Quartz
Rutile
Saltpeter
Sand
Schwarz Oxyd
Selenium
Seleniate Soda
Silica
Silex
Silver Carbonate

Smalte
Soft Soap
Soda Antimonate
Soda Ash 58%
Soda Bicarbonate
Soda Nitrate, Crystal
Soda Silica, Fluoride
Soda Silicate
Soda Sulphate
Steatite
Sulphur
Talcum
Thick Oil
Tin Oxide
Umber Burnt
Uranium, Nitrate
Whiting
Zaffer
Zinc Oxide, AAAI
Zirconium Oxide

Our representatives look forward to seeing you at the Chicago Convention, Feb. 4–9.

The ROESSLER & HASSLACHER CHEMICAL CO.

709 SIXTH AVENUE NEW YORK, N. Y.

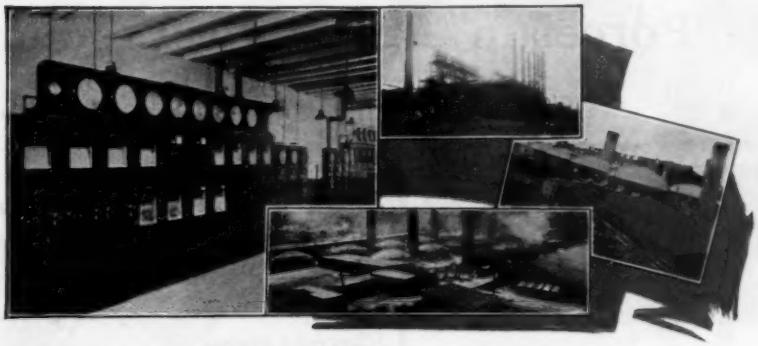
"AMERICA'S LEADING CERAMIC MATERIAL HOUSE"

SALES OFFICES AND WAREHOUSES

40 Central Street Boston, Mass.	230 E. Ohio Street Chicago, Ill.	607 Hanna Bldg. Cleveland, Ohio	860 Drexel Bldg. Philadelphia, Pa.	2018 Guinotte Ave. Kansas City, Mo.
301 O. T. Nat'l Bk. Bldg. Baltimore, Md.	505 Fulton Bldg. Pittsburgh, Pa.	625 Market St. San Francisco, Calif.	813 Louisiana Bldg. New Orleans, La.	23 LaSalle Ave. Trenton, N. J.

FACTORIES

Perth Amboy, N. J. St. Albans, W. Va. El Monte, Calif.
Niagara Falls, N. Y.



Leads Long or Short =

. . . the Accuracy is the Same With the L & N Potentiometer Pyrometer

Automatic Temperature Control

L & N Potentiometer Control is Profit Control. Catalog 87-K, "Potentiometer Pyrometers," and Catalog 84-K, "Potentiometers For Automatic Temperature Control," sent free upon request. Write for copies today.

TEN feet, a hundred, five hundred—it makes no difference in the accuracy of the sturdy, accurate L & N Potentiometer Pyrometer.

This is because the L & N uses the potentiometer principle—and uses it *practically*.

By this principle, no current flows from the thermocouple. Instead, the voltage of the thermocouple is opposed by a known and opposite voltage, and the readings taken as the two are balanced. With no current flowing, there are no variables due to resistance. Therefore length of leads is immaterial.

That's what makes L & N Potentiometer Pyrometers more dependable—different from all others.

LEEDS & NORTHRUP COMPANY
ELECTRICAL MEASURING INSTRUMENTS
PHILADELPHIA, PA.

BRANCH OFFICES: CLEVELAND, CHICAGO, HOUSTON, LOS ANGELES, SAN FRANCISCO

The L&N *Different from all others*

Potentiometer

most accurate* • • PYROMETER • • *in industry

4A

CREATING DEMAND for Porcelain Enameled Products

THE striking advertisement shown at the left is typical of the convincing messages that ARMCO is directing to millions of users and prospective users of porcelain enameled products.

It appears in February Good Housekeeping magazine.

If you use ARMCO Ingot Iron, this advertising is certain to be reflected in increased demand for the products you make. That is the gratifying experience of the many enamelers who have standardized on "the iron that's ideal for enameling."

Cuts Production Costs... Makes for Profitable Sales

Fewer cull losses, speedier and more efficient production practice, bigger profits—that's what you gain with ARMCO Ingot Iron.

Enamelers everywhere know the economies and efficiencies that go with this pure iron that is specially processed to insure uniform and satisfying results.

The office nearest you will be glad to tell you the rest of this interesting story.

The American Rolling Mill Company
Executive Offices: Middletown, Ohio

Export: The ARMCO International Corporation
Cable Address—ARMCO, Middletown (O)

District Offices:

Chicago	Detroit	Pittsburgh
Cincinnati	New York	St. Louis
Cleveland	Philadelphia	San Francisco

ARMCO
INGOT IRON
PURE—UNIFORM
DEGASIFIED

(When writing to advertisers, please mention the JOURNAL)

FISHER

THE ORIGINAL—modernized to today's need of automatic accuracy and sensitive control.

Away back in 1880 FISHER built their first "pump governor"—in fact it was industry's first successful governor and it established a regulating device practice that is now indispensable.

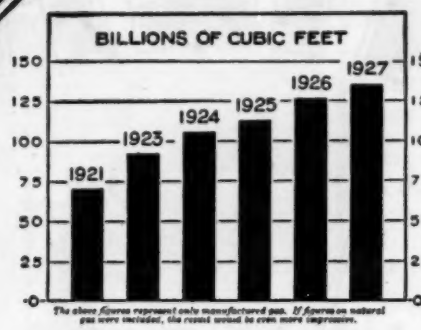
Through the following years of power changes—increased pressures—greater demand for maintained accuracies and more automatic operations—FISHER pioneered every "pump governor" improvement.

Today FISHER is the standard of engineer's service comparison. Simplicity of construction, ease in adjustment, automatic control, and protection for the pump, pipe, fittings, hose, or other equipment. Economical—saving the operator's time and consuming only a minimum amount of steam, gas, or air.

Built in a full range of sizes from ⅜" to 16", cast iron or steel, various trimmings, angle and globe, screwed and flanged ends. Write for Bulletin No. 1.

Fisher Type No. 1 Constant Pressure Pump Governor, for discharge pressures from 10 to 500 lbs.

THE FISHER GOVERNOR CO.
100 Fisher Bldg. Marshalltown, Iowa



The above figures represent only manufactured gas. If figures on natural gas were included, the result would be even more impressive.

GAS for Industry
—a remarkable growth

THE above graph tells a most impressive story—a story that furnishes real food for thought.

Within six short years, the sales of manufactured gas in the United States for industrial and commercial purposes have practically doubled!

Approximately 135 billion cubic feet of manufactured gas were used industrially and commercially in 1927—a staggering figure!

Today, industry is using gas for 60,000 different purposes.

Such a widespread and fast-growing acceptance of gas for industrial uses proves beyond all question the advantages and economies inherent in this superior fuel.

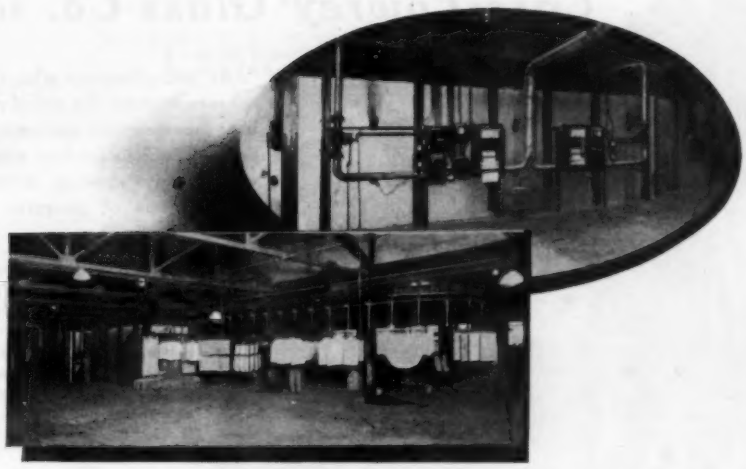
Industrial organizations which investigate and adopt gas, quickly note the very real benefits which accrue, and this has played a large part in the rapid advancement of gas for industrial purposes.

There are very definite ways in which gas will aid production in your plant and bring increased profits to you. Your local gas company will be glad to confer with you and tell you about them. Telephone or write your gas company today—no obligation will be incurred by so doing.

For free copy of book, "Industrial Gas Heat", address

American Gas Association
420 Lexington Avenue, New York City

YOU CAN DO IT BETTER WITH GAS



Continuous Enameling Furnace Built by CARBORUNDUM

REG. U. S. PAT. OFF.

FURNACE designed for producing porcelain enamel signs.

Heated by the Carboradiant combustion chamber method—chambers built of Carbofrax—the Carborundum Brand Silicon Carbide Refractory.

Capacity equal to that of 6 to 8 batch type furnaces—over all labor-saving as compared with batch type furnace operation above 50%.

Size of furnace—working space 85 feet long—cross section dimensions, 4 feet wide by 5 feet high.

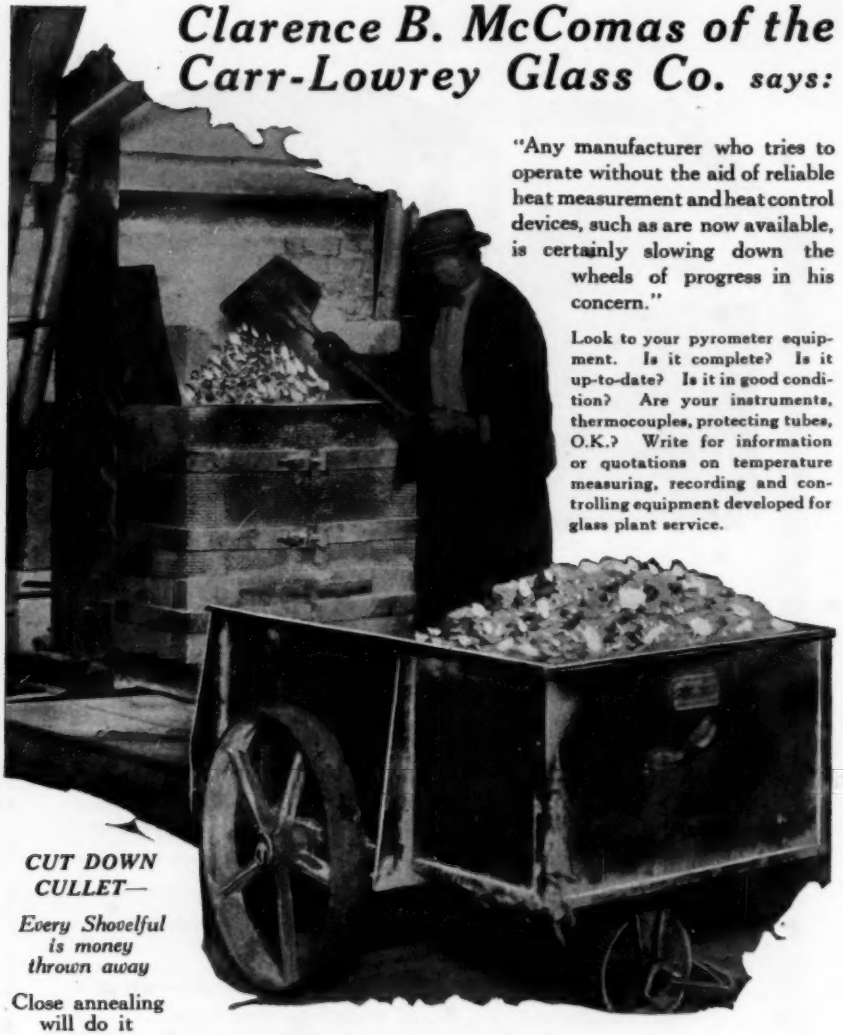
Designed, built and installed by The Carborundum Company for The Baltimore Enamel and Novelty Company.

Foundation Furnaces for heating and heat treating. › Malleable Iron Annealing Furnaces. › Continuous and Batch Type Furnaces for the porcelain enameling of steel and iron. Special High Temperature Furnaces to meet special conditions. › Ceramic Kilns.

THE CARBORUNDUM COMPANY, PERTH AMBOY, N. J.

(Carborundum is the Registered Trade Mark of The Carborundum Company for its Silicon Carbide and is its exclusive property)

Clarence B. McComas of the Carr-Lowrey Glass Co. says:



"Any manufacturer who tries to operate without the aid of reliable heat measurement and heat control devices, such as are now available, is certainly slowing down the wheels of progress in his concern."

Look to your pyrometer equipment. Is it complete? Is it up-to-date? Is it in good condition? Are your instruments, thermocouples, protecting tubes, O.K.? Write for information or quotations on temperature measuring, recording and controlling equipment developed for glass plant service.

CUT DOWN CULLET—

Every Shovelful is money thrown away

Close annealing will do it

THE BROWN INSTRUMENT COMPANY
4484 Wayne Ave., Phila., Pa.
Branches in 20 principal cities

Brown Pyrometers

"To measure is to economize"—PASCAL

(When writing to advertisers, please mention the JOURNAL)

Table of Contents

FEBRUARY, 1929

The Journal

Scratch Hardness Tests of Ceramic Materials—Navias 69
Smooth-Surface Tile—Schory 75
Pyrophyllite, A New Ceramic Raw Material—Shelton 79
The Action of Fluorine in Enamel Smelts—Wilcox and Westendick 83
New Method of Direct Firing Glazed Ceramic Bodies—Whitaker 87
A Tunnel Kiln Refractories Plant—Whitesell 96
A Completely Automatic Decorating Tunnel Kiln—Jans 107
Some Leadless Borosilicate Glazes Containing Nickel Oxide—Holscher 111
A Study of the Absorption of Two Earthenware Bodies and Their Resistance to Crazing in the Steam Test—Wright 118
The Service of Refractory Blocks in a Small Experimental Glass Tank—Pendergast and Insley 123

Ceramic Abstracts

79

The Bulletin

Editorial
Our Financial Deficit 31

Activities of the Society
American Ceramic Society Financial Report for 1928 33
New Members Received from December 1 to January 1 35
Local Section Meetings:
Pittsburgh Section 36
Michigan-Northwestern Section 36

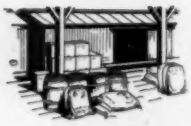
Notes and News
Ceramic School Notes:
Heavy Products Short Course at Iowa State College 36
Research at Illinois 37
Society of Glass Technology 37

Calendar of Conventions 39

Advertisers' Index 31

WHAT HF&G OFFERS
The Ceramic Industry

GOLD
CLAYS
SILICA
BORAX
CHALK
OCHRE
SILVER
RUTILE
UMBER
CERIUM
ARGOLS
ARSENIC
LUSTRES
WHITING
SODA ASH
FELDSPAR
SELENIUM
CALCSPAR
COPPERAS
BONE ASH
LEUKONIN
TIN OXIDE
KRYOLITH
WAD CLAY
BALL CLAY
SALT CAKE
FLUORSPAR
BORIC ACID
ZINC OXIDE
LEAD OXIDE
CHINA CLAY
WHITE LEAD
BROWN GOLD
SAGGER CLAY
POWDER BLUE
NICKEL OXIDE
COBALT OXIDE
COPPER SCALE
GLASS COLORS
TUSCANY ACID
PLASTER PARIS
IRON SULPHIDE
URANIUM OXIDE
CADMIUM OXIDE
IRON CHROMATE
TITANIUM OXIDE
COBALT NITRATE
ZINC CARBONATE
VALLENDAR CLAY
SODIUM NITRATE
CERAMIC COLORS
ANTIMONY OXIDE
POWDERED GLASS
ALUMINUM OXIDE
SODIUM URANATE
CHROMIUM OXIDE
SODIUM SELENITE
NICKEL SULPHATE
CORNWALL STONE
NICKEL CHLORIDE
SILICATE OF SODA
BARIUM FLUORIDE
COBALT CHLORIDE
COBALT SULPHATE
SODIUM FLUORIDE
ZIRCONIUM OXIDE
URANIUM NITRATE
MAGNESIUM OXIDE
MANGANESE OXIDE
NEEDLE ANTIMONY
COPPER OXIDE RED
OVERGLAZE COLORS
CADMIUM SULPHIDE
COBALT CARBONATE
COBALT PHOSPHATE
COPPER CARBONATE
POTASH CARBONATE
BARIUM CARBONATE
CHROMIUM NITRATE
POTASSIUM NITRATE
HYDROFLUORIC ACID
ZIRCONIUM SILICATE
SODIUM ANTIMONATE
SODIUM BICHROMATE
UNDERGLAZE COLORS
COPPER OXIDE BLACK
IRON OXIDE CERAMIC
LIQUID BRIGHT GOLD
CHROMIUM CHLORIDE
MAGNESIUM SULPHATE
ENAMEL OXIDE COLORS
AMMONIUM CARBONATE
AMMONIUM BIFLUORIDE
MAGNESIUM CARBONATE
MANGANESE CARBONATE
SODIUM SILICOFLUORIDE



A source of supply for every material and chemical involved in the production of ceramic products, backed by an intimate knowledge of their function.

1929

Thirty-five years of research and production of products whose excellence and uniformity have been proven by practically every user of ceramic materials.

A purchasing convenience that makes practical concentrated buying and effects a definite saving in time and clerical detail.

A geographical location of ample stocks that insures the dependable delivery of material when and where it is needed.

The Harshaw Fuller & Goodwin Co.

Home Office, Cleveland **Branches at Principal Points**

SCRATCH HARDNESS TESTS OF CERAMIC MATERIALS[1]

By Louis Navias

ABSTRACT

Three sets of standards were prepared: (1) a set of minerals according to Mohs' Scale, (2) a set of steel samples, and (3) a set of Carboloy (tungsten carbide alloy) samples. The sets of standards were compared with each other according to their scratch hardness. Specimens of ceramic materials were then measured for scratch hardness with each set of standards. The results are compared.

Introduction

The present investigation was initiated by the appearance in the Standard Test Methods of 1928[2] of the test for hardness of fired clay specimens by comparing the ceramic trials with steel. The test does not specify steel and is rather inadequate. The work recorded here is to be considered as a preliminary study designed to bring the subject to attention for future work on standards.

Preparation of Sets of Standards

(1) Mineral Standards The set of ten minerals appearing in Mohs' scale of hardness was used. The minerals are listed in the tables.

(2) Steel Standards A bar of iron was cut into short lengths and the sections given different heat treatments, according to metallurgical practice. A set of seven standards was thus obtained. As the hardest of these was not hard enough for some of the ceramic materials, a piece of Haynes Stellite was included in the set. It is practically the hardest steel tool material available.

(3) Carboloy Standards As standards with greater hardness than the steel standards were required, advantage was taken of Carboloy[3] the new tool material, consisting of the very hard tungsten carbide alloyed with a metal like cobalt. According to the Rockwell "A" number scale of hardness the standard Carboloy product has a hardness above 85. For the present work, standards were needed with hardness values below 85. These were obtained by selecting partially or poorly sintered samples of Carboloy, and listing them according to their hardness. It is well to bear in mind that the tungsten carbide contained in the partially and fully sintered samples of Carboloy is equally hard in both but that the aggregate hardness of the fully sintered

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received December 14, 1928.

[2] Standard Test Methods, No. 58, "Hardness of Clay Trials," *Jour. Amer. Ceram. Soc.*, **11** [6], 457 (1928).

[3] Samuel L. Hoyt, "Carboloy, a New Tool Material," *Gen. Elec. Rev.*, **31**, 585–91 (1928).

sample is considerably greater. The partially sintered material is also usually more porous, allowing the aggregate to yield. A set of eight Carboloy standards was used.

Measuring the Hardness of the Standards

(1) Scratch Hardness Each set of standards was arranged according to scratch hardness, the ability of one specimen to scratch another. The scratch hardness is influenced by a number of factors, as the sharpness or bluntness of the tool edge, the force applied on the tool edge, the smoothness or roughness of the surface being scratched, the porosity of the specimen being scratched.

In these experiments the scratches were made with the standards held in the hand and attempts were made to give them all the same pressures. The scratches were examined with a high power lens. With some specimens, erasing the newly formed scratch or mark with a rubber eraser helped to determine whether a true scratch or cut in the specimen lay below the surface mark. In all cases, each specimen was treated as a standard and as an unknown. The standards are listed in Table I according to their scratch hardness, the hardest materials coming first.

(2) Brinell Hardness The steel standards were measured for hardness by the Brinell method, in which a hardened steel ball is pressed into the specimen under a definite load.

The maximum diameter of the impression is measured and the Brinell hardness numbers calculated from the formula:

$$H = \frac{P}{\frac{\pi D}{2}\left(D - \sqrt{D^2 - d^2}\right)}$$

Where H = Brinell hardness number (kgs. per sq. mm.)
P = load in kgs. (3000 kgs.)
D = diameter of ball (10 mm.)
d = diameter of impression in mm.

The values are given in Table I. The Brinell hardness of the stellite could not be obtained, as the stellite was as hard as the steel ball.

(3) Rockwell "A" Numbers (hardness) In the usual Rockwell test for hardness of metals, a diamond cone or penetrator is forced into the specimen under a load of 150 kgs. The penetration is registered on an arbitrary scale (dial), the higher the "C" scale reading, the harder the material. For Carboloy,[3] the load has been changed to 64 kgs., and the readings on the "C" scale are known as Rockwell "A" numbers. This change was found necessary

from a practical standpoint as the breakage of diamond points under the heavier load was considerable.

The Rockwell "A" numbers were determined for all the Carboloy specimens, and the corresponding Brinell numbers for the standard products determined from curve given by Hoyt.[3] The values are listed in Table I.

Explanation of Table I

(1) Scratch Hardness of Standards In Table I, the three sets of standards are listed according to scratch hardness of the members of each set. The standards are also staggered in the table to show the relative positions of all the standards according to their scratch hardness, giving also the quantitative data where possible.

The two sets of metal standards, the Carboloy and steel standards, cover a wide range of scratch hardness due to the fact that one set practically ends where the second set begins. The Rockwell "A" numbers for the Carboloy set do not have the same significance as the Rockwell "A" numbers for the steel set of standards. Carboloy standard (5) which is scratched by corundum and not scratched by topaz has a Rockwell "A" number of 82.8, whereas stellite which is equivalent in scratch hardness to quartz has a similar Rockwell "A" number, 83. Carboloy standard (5) very readily scratches stellite, which is also scratched by Carboloy standards (6) and (7), but not by (8).

(2) Scratch Hardness of Ceramic Materials All the ceramic materials were tested for scratch hardness with each of the sets of standards, and the materials are listed accordingly in three columns in Table I. The hardness decreases successively down the columns. Materials of about the same hardness are bracketed together. A material placed on the same line with a standard is considered to be of equivalent scratch hardness. The list of materials with a few remarks is given in Table III.

Discussion of Results

(1) Steel Standards The best steel standards do not scratch the porcelains and high-fired products. The set of steel standards covers the range of glazes, glasses, and enamels fairly well.

(2) Carboloy Standards The porcelains and high-fired products may be classified according to scratch hardness by means of the Carboloy standards. More tests will have to be made to determine whether the partially sintered specimens are true standards. There is need for more intermediate members.

TABLE I

Mohs' Scale			Carboloy Standards				Steel Standards			
Mineral	Hardness	Scratch test	Specimen No.	Brinell hardness scale (kgs./sq. mm.)	Rockwell "A" numbers	Scratch test	Specimen No.	Brinell hardness scale (kgs./sq. mm.)	Rockwell "A" numbers	Scratch test
Diamond	10									
			(1)	2000	90					
Corundum	9									
			(2)	1500	87.3					
			(3)	1400	86.7	Chemical porcelain				
			(4)	1200	84.3					
			(5)		82.8					
			(6)		76.8	Spark plug porcelains				
						Insulator porcelains (*a*) High fire; (*b*) Medium fire; (*c*) Dry process				
			(7)		75.5	Spark plug porcelain glaze				
Topaz	8	Chemical porcelain				Chemical porcelain glaze; Insulator porcelain glazes (*a*) and (*b*); Stoneware; Chemical glassware; Vitreous enamels				
		Spark plug porcelain								
Quartz	7	Spark plug porcelain; Insulator porcelains (*a*) and (*b*)					(1)	Stellite	83	
			(8)		68.8	White earthenware				
		Chemical porcelain glaze; Insulator porcelain glaze (*a*); Insulator porcelain (*c*); Stoneware								
							(2)	713	79	Spark plug glaze; Chemical porcelain glaze; Insulator porcelain glaze (*a*); Chemical glassware; Vitreous enamels
Orthoclase	6	Spark plug porcelain glaze; Chemical glassware					(3)	600	75.5	Insulator porcelain glaze (*b*); White earthenware
		Vitreous enamels; Insulator porcelain glaze (*b*); White earthenware								
Apatite	5	Bottle glass					(4)	477	68	
							(5)	387	66	
							(6)	340	63	
							(7)	286	60	Bottle glass
Fluorite	4									
							(8)	163	50	
Calcite	3									
Gypsum	2									
Talc	1									

TABLE II

Mohs' Scale	Carboloy Standards	Steel Standards
Chemical porcelain	Chemical porcelain	
Spark plug porcelain (1)	Spark plug porcelain (1), (2)	
Spark plug porcelain (2)		
Insulator porcelains	Insulator porcelains	
(*a*) High fire	(*a*) High fire	
(*b*) Medium fire	(*b*) Medium fire	
	(*c*) Dry process	
		(Stoneware)
Insulator porcelain (*c*) Dry process	Spark plug porcelain glaze	Spark plug porcelain glaze
Chemical porcelain glaze	Chemical porcelain glaze	Chemical porcelain glaze
Insulator porcelain glaze (*a*)	Insulator porcelain glazes (*a*) and (*b*)	Insulator porcelain glaze (*a*)
Stoneware	Stoneware	
Spark plug porcelain glaze		
Chemical glassware	Chemical glassware	Chemical glassware
	Vitreous enamels	Vitreous enamels
Vitreous enamels		
Insulator porcelain glaze (*b*)		Insulator porcelain glaze (*b*)
White earthenware	White earthenware	White earthenware
Bottle glass	(Bottle glass)	Bottle glass

(3) Mineral Standards The minerals afford a fairly reliable set of standards, covering a wide range of scratch hardness. With intermediate members of hardness between 5, 6, 7, and 8, the mineral standards could be made fairly adequate for ceramic materials.

(4) Classification of Ceramic Materials According to Scratch Hardness In Table II the ceramic materials are listed according to their scratch hardness, to enable easy comparison between the three lists. As a whole the results are the same for each set of standards, within their limits of hardness. The stoneware sample is an exception, in that it stands above the steel standards, and yet is scratched by quartz and Carboloy (7). Insulator porcelain glaze (*b*) stands higher in the Carboloy series than it does in the mineral series or steel series. A rechecking of the determinations leaves the results the same.

TABLE III

Chemical porcelain (American manufacture)
Spark plug porcelains (2 American makes)

Insulator porcelains
(*a*) High fire (German manufacture)
(*b*) Medium fire (cast process and wet process, American)
(*c*) Dry process (American)

Stoneware (German insulator material)
Chemical glassware (American manufacture)
Vitreous enamels (ground coat and cover coat, leadless refractory enamels, American)
White earthenware (American porous dishware)
Bottle glass (American)

Other References

LeChatelier and L. Bogitch, "Brinell Ball Test for Ceramic Materials," *La Céramique*, **371**, 17–18 (1919). A modified method in which a hardened steel ball

17.5 mm. diameter is applied with a weight of 500 kg. pressure. The indentation is measured on a thin lead foil placed between ball and material.

G. Blumenthal, Jr., "Notes on the Hardness of Glazes," *Jour. Amer. Ceram. Soc.*, **4**, 896–901 (1921). A hardened tungsten-steel point is allowed to bear on the glaze surface for 3 minutes under a pressure of 50 lbs.

$$H = \frac{p}{\pi t D}$$

where H = hardness, p = load, t = depth of indentation in mm., D = diameter of indentation

$$t = \frac{D}{2} - \sqrt{\frac{D^2}{4} - \frac{d^2}{4}}$$

where d = diameter of indentation.

Acknowledgment Is made to several members of the Metallurgical Division of the Research Laboratory for their assistance in this work.

Research Laboratory
General Electric Company
Schenectady, N. Y.

SMOOTH-SURFACE TILE[1]

By V. S. Schory

ABSTRACT

A series of experiments is described by which a body suitable for the manufacture of smooth-surface tile was developed. The effects of certain raw materials and of the firing conditions are reported.

The terms "smooth-surface tile" and "quick-cleaning ceramic" are used to denote a grade of vitreous floor tile that cannot readily be defined in a single phrase. The surface of these tile feels soapy or oily to the touch much as does a piece of talc. The surface does not resemble a glass or a glaze nor is it the glossy surface sometimes produced by overfiring or by increased vitrification due to the deposition of soluble salts near the surface of the tile. The surface is not the result of unusual polish of the die in which the tile are pressed. The development of this smooth surface is of most importance in the case of white vitreous floor tile. The usual dry, gritty surface facilitates the attachment of dirt under the abrasive action incident to daily use and the dirt often adheres tenaciously. In the case of the darker colored vitreous tile the discoloration from dirt is not so noticeable and the usual harsh surfaced tile are acceptable.

The problem of producing the desirable surface on white vitreous dust-pressed tile presented itself in a factory manufacturing numerous kinds of tile. To satisfy the requirements of the range of products manufactured two biscuit heats were used in the regular kiln practice. The one was an oxidizing fire varying from cones 4 to 7 in different parts of the kiln. In this kiln were fired tile containing considerable percentages of red-firing and buff-firing clays. The other biscuit heat varied from cones 10 to 13 in different parts of the kiln and was applied to porous wall tile and vitreous floor tile, these tile bodies being compounded of white firing clays, flint, and feldspar. During the latter part of this firing reducing conditions were maintained in the kiln.

Previous to the writer's connection with the factory various attempts had been made over a period of five years to produce white tile with the desired surface but no success had been attained. In attacking this problem one clue was observed. The vitreous cream tile regularly made showed the desired surface to a moderate degree. These tile were made of a body compounded from white firing materials, Kentucky ball clay, and a buff-firing fire clay, and were fired to cone 6. All other vitreous tile produced had a gritty surface to which the trade objected as not being readily cleaned. It was noted that the gritty surface occurred on vitreous tile which on breaking showed an excellent glassy fracture.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received Nov. 13, 1928.

In fact the surface of tile giving a glassy fracture was apparently no better than the surface of tile showing a stony fracture. Porcelain bodies consisting of ball clay, china clay, and feldspar only, gave tile showing an excellent fracture but with a similar dry, harsh surface.

In the work done on this problem the operations and processes of regular factory practice were duplicated in manufacturing tile from the bodies used. The tile were pressed from dust containing approximately 10% moisture, using hydraulic pressure.

In beginning the work several bodies were prepared based upon the vitreous cream above mentioned with the omission of the content of buff-firing clay.

Body	(1)	(2)	(3)	(4)
Flint		5	10	15
Me. feldspar	66	63	60	57
N. C. china clay	18	16	14	12
Ky. ball clay	16	16	16	16

Tile pressed from each of these bodies were fired to cones 10, 11½, and 13 so that vitrified ware of each body would be obtained in the first firing. The surface in all cases was dry and gritty.

In the next series of bodies English china clay was used.

Body	(5)	(6)	(7)	(8)
Flint		5	10	15
Me. feldspar	54	52	50	48
Eng. china clay	30	27	24	21
Ky. ball clay	16	16	16	16

As with the previous group, pieces were fired to cones 10, 11½, and 13. The surface was of the same character as that developed on Bodies 1 to 4.

Following these mixtures numerous variations in raw materials were made both as to the source of the materials and the proportions used with disappointing uniformity in results as far as the surface of the tile was concerned.

The work then reverted to the place of beginning. Tiles were pressed from the vitreous cream body and from Body 9, the latter being a duplicate of the vitreous cream body except that the buff-firing clay was omitted. Tiles of these two bodies were fired side by side to cones 6, 7, and 10. Both kinds of tile developed fairly good "smooth surface" effects at cones 6 and 7, showing that the buff-firing clay used in the vitreous cream body was not essential to the production of the desired surface. At cone 10 the surfaces of both kinds of tile were dry and gritty.

These results in connection with the results of Bodies 1 to 8 indicated that the reduction occurring in the higher fire was unfavorable to the production of smooth surface tile.

In accordance with these conclusions two bodies were prepared, designed for cone 7 fire.

Body	(10)	(11)
Flint		5
Me. feldspar	70	67
Eng. china clay	14	12
Ky. ball clay	16	16

The tile made from Bodies 10 and 11 developed a fairly good surface at cone 7. The color, however, was not a good white. Bodies 1 to 8 with 16% Kentucky ball clay gave tile of fairly good color at cones 10 to 13 because of the reduction occurring during the latter part of the firing but tiles of Bodies 10 and 11 with the same ball clay content and fired under oxidizing conditions to cone 7 were decidedly yellowish in color.

In order to improve the color the ball clay content was reduced in the next series of bodies.

Body	(12)	(13)	(14)
Flint		5	10
Me. feldspar	70	66	62
Eng. china clay	22	21	20
Ky. ball clay	8	8	8

Tile pressed from Bodies 12 to 14 all fired to a fairly good ivory white color at cone 7 and all developed the desired smooth surface to a considerable degree. Bodies 13 and 14 were more satisfactory in every way than any preceding numbers.

Following these results a number of bodies were prepared, taking Bodies 13 and 14 as a basis and introducing variations in the raw materials used.

Body	(15)	(16)	(17)	(18)	(19)	(20)
Flint	5	10	10	9	7	10
Conn. feldspar	65	62				
Tenn. feldspar			62	62	62	62
Eng. china clay	22	20	20	21	23	20
Fla. clay						8
Ky. ball clay	8			8	8	
Tenn. ball clay		8	8			

Tile of all the above bodies were fired to cone 7 and all were a good ivory white color. Tile pressed from Body 20 fired whitest and had a very good surface but the low plasticity of the body made the tile more liable to chipping in the unfired state. Tile of Bodies 15 and 16 had fairly good smooth surfaces and closely resembled those of Bodies 13 and 14. Body 17 gave better results than Body 16. Tile pressed from Bodies 18, 19, and 20 were superior to those from Body 17 and all developed excellent surfaces.

Body 21 is a modification of Body 19.

Body	(21)
Flint	7
Conn. feldspar	31
Tenn. feldspar	31
Eng. china clay	23
Ky. ball clay	8

Body 21 has been used for a number of years for the manufacture of "quick cleaning ceramic" and has proved uniformly satisfactory in regular factory practice. The ware has given satisfaction on the market and in service.

The results of this investigation show that it is inadvisable to attempt to produce "smooth surface" tile in a sharply reducing fire. The degree of reduction resulting in a harsh surface and the degree of oxidation necessary to the production of a satisfactory smooth surface were not determined. It was also found that different brands of feldspar produced variations in the surface. These variations, however, were variations in the degree of development of the smooth surface and not differences in the essential character of the surfaces. Tile of Bodies 12 to 21 all developed the surface in question, though in varying degree, when fired to cone 7 in an oxidizing atmosphere but when fired to cone 10 with reduction taking place all had the harsh dry surface characteristic of the tile of Bodies 1 to 8. Feldspars from Tennessee and North Carolina gave markedly better surfaces than feldspars from Maine and Connecticut. No explanation of this fact is suggested. No attempt was made to use North Carolina kaolin or Florida kaolin for the entire china clay content of the bodies. The clay content of bodies having feldspar as the fluxing agent and vitrifying at cone 7 is necessarily quite low and in this work was made as high as feasible by using an easily vitrifiable English china clay. Several plastic clays are available for use in this type of ware as is shown by Bodies 17, 18, and 20.

For the successful production of "smooth surface" tile the proper composition of the body is important. But it is of greater importance that proper conditions of the kiln atmosphere obtain during the firing operation.

STANDARD SANITARY MFG. COMPANY
KOKOMO, INDIANA

PYROPHYLLITE, A NEW CERAMIC RAW MATERIAL[1]

By G. R. Shelton

ABSTRACT

The relationship among the minerals pyrophyllite, kaolinite, and steatite together with a statement of the properties of pyrophyllite are given. The North Carolina deposits of pyrophyllite are briefly described. A preliminary report is made on tests now being conducted to determine the possible use of pyrophyllite as a constituent in whiteware bodies.

Introduction

Pyrophyllite is a mineral related to kaolinite and steatite. It is like kaolinite in its composition and like steatite in certain physical properties. Both pyrophyllite and kaolinite are hydrated alumino-silicates, while steatite is a hydrated magnesium silicate. Pyrophyllite and steatite are alike in that both are soft and have a greasy feeling when rubbed between the fingers, and both are called "talc" and "soapstone."

Composition and Properties

The percentage composition of pyrophyllite is silica 66.7, alumina 28.3, and water 5. Its formula is $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$. Larsen states that its optical properties are α, 1.552; β, 1.588; γ, 1.6; $2V$ dispersion, 57°; $\rho > v$ weak; $X = c$; $Z \,||$ length; orthorhombic. Its hardness is 1 to 2 and specific gravity 2.8 to 2.9.

Stuckey[2] found that the dehydration is effected only at high temperatures. Theoretically the fusion point of the pure mineral should be about 1900°C. When tested a sample fused at cone 27.

North Carolina Deposits

The only known deposits of commercial importance in the United States are found in the Deep River region of North Carolina. These deposits lie in the Piedmont plateau in the central part of the state, in the following counties, Moore, Chatham, Randolph, Montgomery, Alamance, Orange, and Granville. A special area about 25 to 30 miles long by 6 to 8 miles wide in Moore and Chatham Counties contains the most important deposits. All important deposits are near railroads.

Origin and Distribution

Evidence points to the formation of pyrophyllite by hot solutions coming from below, probably in the same way that gold deposits in this

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received December 6, 1928.

[2] J. L. Stuckey, *Jour. Amer. Ceram. Soc.*, **7** [10], 735 (1924).

region were formed. This has a bearing on the depth at which the pyrophyllite may reasonably be expected to extend, since gold has been mined to a depth of 800 feet. At present the depth of deposits are "considerable, and continuous but unknown." Stuckey says that a minimum depth of 500 feet may be expected. The pyrophyllite deposits and the geology of the Deep River region have been described by J. L. Stuckey,[3] Professor of Geology at North Carolina State College. Dr. Stuckey has given the present uses of pyrophyllite and has also called attention to the fact that it should receive notice from the ceramic industries.

The deposits are in irregular lens-shaped bodies, which vary from a few inches in width to several hundred feet, and in length from a few feet to a quarter of a mile. Deposits separated on the surface by a short distance are probably connected below and form one continuous zone.

The method of mining is by open cuts and shallow pits. The Standard Mineral Company near Hemp, however, has mined by shaft, which extends to a depth of 200 feet.

The color of pyrophyllite varies from nearly black, through yellowish white, green to pure white, according to the amount of impurities it carries. The associated minerals are quartz, chloroloid, sericite, pyrite, feldspar, and iron oxides.

The following chemical analyses are typical of samples taken from widely separated localities.

CHEMICAL ANALYSES OF PYROPHYLLITE[4]

	(1)	(2)	(3)
SiO_2	57.58	64.68	64.54
Al_2O_3	33.31	28.34	28.88
Fe_2O_3	0.33	0.60	0.45
MgO	Trace	Trace	Trace
CaO	Trace	0.72	0.36
Na_2O	0.06	0.38	0.12
K_2O	3.90	0.01	0.18
H_2O	4.96	5.54	5.40

(1) Standard Mineral Company's Mine, J. L. Stuckey.
(2) Womble Mine, J. L. Stuckey, Analyst.
(3) Gerhardt Brothers, Staley, N. C., E. E. Randolph.

Substitution in Bodies

Laboratory work on substituting pyrophyllite for one or more of the usual ingredients of commercial whiteware bodies, has not been completed. Only a preliminary report can be made at this time on a test to determine the effect on plasticity when pyrophyllite is substituted for ball clay.

[3] *Ceramist*, **7** [4], 215 (1926); *Ceram. Age*, **9** [2], 48 (1927); North Carolina Dept. Conservation and Development, *Bull.*, No. 37, 1928.

[4] J. L. Stuckey, *Bull.*, No. 37, p. 18, N. C. Dept. Cons. & Dev.

In substituting pyrophyllite for clay the proper reduction in flint must be made, since a molecule of calcined pyrophyllite may be considered the equivalent of one molecule of calcined kaolinite, and two of flint, thus

$Al_2O_3 \cdot 4SiO_2$		$Al_2O_3 \cdot 2SiO_2$	+	$2SiO_2$
Calcined pyrophyllite		Calcined kaolinite		Flint

Experimental work was carried out on typical earthenware and floor tile bodies.

The following table gives the batch weights of the extremes of both bodies, from which blends were made in both cases.

	Earthenware (cast)		Floor tile (dry pressed)	
Materials	I	II	I	II
North Carolina kaolin	20	20	10	10
Golding & Sons china clay			10	
Tennessee ball No. 9	30		15	
Pyrophyllite*		42		35
Feldspar	15	15	50	50
Flint	35	21	15	6.7
Whiting				1

* Pyrophyllite for these tests was furnished by R. T. Vanderbilt Company from their mine near Hemp, N. C.

Three intermediates in each body were made by blending extremes I and II. The cast earthenware and dry-pressed tile pieces were fired to cones 6 and 8, and tests made on plasticity and strength of dried body, and color, shrinkage, and absorption on fired ware.

Results

Only general statements of results can be made in this preliminary report. With increase of pyrophyllite and decrease of ball clay there was a marked decrease in plasticity. The bodies containing no ball clay were almost too fragile to handle. There was an increase in whiteness with increase of pyrophyllite. The floor tile bodies showed a greater density with less absorption and increased shrinkage in test pieces having increasing amounts of pyrophyllite.

Further Studies

Pyrophyllite should decrease the amount of abrasion on dies used in shaping floor and wall tile, due to its talclike properties. Experiments are in progress to determine the effect on lubrication of tile bodies when pyrophyllite is substituted for flint which is probably the chief abrasive ingredient in such bodies. The whole question of abrasion caused by the common body ingredients is one on which there is no definite answer

at present. Preliminary tests to measure abrasion produced by these ingredients and also by pyrophyllite are being conducted.

Use of pyrophyllite as a refractory is receiving attention.

Pyrophyllite as a constituent of both fritted and raw glazes is another test being carried out.

If pyrophyllite proves to be a valuable constituent of whiteware bodies, geologists estimate that the North Carolina deposits are sufficiently extensive to supply an industry for many years.

North Carolina State College
Raleigh, N. C.

THE ACTION OF FLUORINE IN ENAMEL SMELTS[1]

By H. G. Wilcox and F. C. Westendick

ABSTRACT

It is proved that all fluorine is not volatilized from enamels and that the duration of smelting and viscosity of smelt affect the amount driven off. These facts were determined by quantitative analysis of enamels of varied compositions smelted under varied time treatments.

Introduction

Although there have been many discussions among enamelists as to the behavior of fluorine during the smelting of enamels, nevertheless surprisingly little experimental work has been attempted. The difficulties inherent in chemical analysis necessary for such work explain in part the reason for this lack. Several theories have been advanced and almost without exception ceramists have shown that the conclusions drawn were not warranted by the data submitted. These theories usually were developed from chemical analyses by mathematical considerations.

A knowledge of the behavior of fluorine in both the smelting and firing operations is important. Without it, the formulas and calculated melted weights are incomplete and probably incorrect. The "fired factor" for cryolite as well as fluorspar is taken as one. The truth of this statement, however, is to be questioned.

The chief emphasis heretofore has been on the chemical form in which fluorine might escape. It is more essential that the conditions attending any probable loss be determined so that allowances may be made in calculations and also deductions made as to what physical factor may then be brought into consideration.

Object of Investigation

The object of this investigation was to determine whether any fluorine is lost during the smelting of enamels and not during the firing. Emphasis was placed upon the quantity of loss, if any, and not the chemical form that it may assume when it is volatilized. Since in industrial practice the time for smelting of the batches varies, the effect that changing the rate of heating has on the amount of loss of fluorine was another factor to be observed. The behavior of fluorides with silica alone was studied to see if increasing that constituent had any bearing on loss of fluorine either by chemical reaction with it or by changing the physical properties of the melt. Increasing the amount of alumina in the presence of silica through the addition of clay was another factor observed as to the probable loss of fluorine.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Enamel Division.) Received December 7, 1928.

Description of Test

Two methods were employed to determine fluorine loss during smelting of enamels. The first method consisted in calculating the loss of weight during firing and the second was a chemical analysis for fluorine in the raw batch and also in the smelted enamel.

In conducting tests by the first method, all crucibles used were given a preliminary firing in the pot furnace to cone 18 to drive off all moisture and to guard against errors arising through loss from volatile matter. The flint, feldspar, and kaolin were calcined to cone 15 in order to insure no errors arising from the same source. When cool, each calcine was ground to pass a 100-mesh sieve, dried in an oven at 110°C, and then kept in a tightly stoppered bottle. In order to find out how much fluorspar the borax, sodium nitrate, and cryolite lost in weight when fused with silica, a mixture of each was heated with flint to cone 16. These were numbered 1, 2, 3, and 4, respectively. From the known weights of the crucibles and contents before and after firing, the percentage loss of weight was calculated.

The enamel batch given below was chosen at random since the test was one of comparison only:

Borax	665 g.	Sodium nitrate	60 g.
Flint	250 g.	Cobalt oxide	10 g.
Feldspar	325 g.	Nickle oxide	13 g.

This was divided into two portions. To the one portion, 35 grams of fluorspar was added, and to the other, 35 grams of cryolite. The one containing fluorspar was designated as No. 7, and the one containing cryolite as No. 10. Mixtures of clay and fluorspar, clay and cryolite, flint and fluorspar, flint and cryolite were made up and numbered 8, 9, 5, and 6, respectively.

Known amounts of each of the 10 mixtures were placed in separate previously calcined and weighed crucibles. These crucibles were then heated to the maturity of the enamel, in the pot furnace. The enamels were considered to be properly smelted when there were no more bubbles in a thread of the melt drawn out by means of an iron rod. After cooling, the crucibles were again weighed and the weight-loss during smelting calculated from the data obtained. All loss not taken care of by those previously determined for borax and sodium nitrate was attributed to the action of fluorine.

The smelts were removed from the crucibles and a representative sample of each was ground for the chemical analysis. A sample of the raw batch of each was analyzed for fluorine at the same time. The method used was that of Berzelius with modification proposed by Penfield and Minor. The sample was decomposed with a sodium carbonate fusion and the cake

well leached with hot water. Ammonium carbonate was added to the filtrate to precipitate the silica, iron, and alumina. This precipitate was filtered off and any trace remaining was precipitated with ammoniacal zinc solution. To the filtrate containing fluorides and carbonates, calcium chloride was added. The precipitate of calcium fluoride and carbonate was filtered and ignited gently. The residue was digested with dilute acetic acid, filtered, and the insoluble material ignited. This was repeated until the carbonate was entirely removed. The calcium fluoride was converted into the sulphate as a check and the gases evolved were tested for hydrofluoric acid.

The only apparatus used was a pot furnace, using compressed air and natural gas, and the ordinary analytical apparatus.

The raw materials were of the commercial grade as used in the normal enameling plant. All chemical reagents were of the C.P. grade.

TABLE I

LOSS ON HEATING MATERIALS

No.	Material	(g.)	SiO_2 (g.)	Loss in wt. (g.)	Loss in wt. of material (%)
1	CaF_2	25	25	2.5	10
2	Borax	15	30	5.5	36.6
3	$NaNO_3$	25	30	13.0	52.0
4	Cryolite	25	30	8.5	34.0

Time: 1 hour, 10 minutes. Temp.: Maturity of enamel.

TABLE II

LOSS IN WEIGHT OF MIXTURES CONTAINING FLUORSPAR

No.	Material	(g.)	CaF_2 (g.)	Loss in wt. (g.)	Loss in wt. of CaF_2 (%)
5	Flint	210.0	140.0	10	7.14
6	Clay	210.0	160.0	20	12.50
7	Enamel	332.5	17.5	1	0.57

Time: 30 minutes. Temp.: Maturity of enamel.

TABLE III

LOSS IN WEIGHT OF MIXTURES CONTAINING CRYOLITE

No.	Material	(g.)	Na_3AlF_6 (g.)	Loss in wt. (g.)	Loss in wt. of Na_3AlF_6 (%)
8	Flint	210	140	30	21.42
9	Clay	210	140	30	21.42
10	Enamel	332.5	17.5	31	176.9

Time: 30 minutes. Temp.: Maturity of Enamels.

TABLE IV

CHEMICAL ANALYSIS

No.	F_2 in raw (%)	F_2 in cake (%)	Loss F_2 (%)
5C	17.08	14.50	2.58
6C	22.96	11.32	11.64
7C	2.51	2.24	0.27
8C	21.67	14.08	7.59
9C	12.91	12.20	0.71
10C	1.70	1.48	0.22

Discussion of Results

The method by loss in weight was of no definite value since the losses which did occur could not be predicted or measured.

The chemical analyses show that some fluorine is lost during smelting but the larger part remains in the enamel. A part of the fluorine was volatilized from mixtures of either a fluoride and silica or a fluoride and clay. The fluorine escaped from the least viscous liquids. This was indicated by the presence of large bubbles in the solidified melts. Mixture No. 9 was an outstanding example. This might be explained by the fact that the high alumina content made the melt more viscous. The alumina in the mixture was the highest since it was introduced from both clay and cryolite. The fluorine may have been volatilized as a gas and then held in suspension in the highly viscous solidified smelt or it may be present in some chemical combination with alumina such as Al_2F_6.

The effect of time on the loss of fluorine was brought out clearly. Fluorspar in a mixture with silica lost 10% by weight when smelted in 1 hour and 10 minutes and only 7.13% when smelted in 30 minutes. Cryolite in a mixture with silica lost 34% by weight when smelted in 1 hour and 10 minutes, and only 21.4% when smelted in 30 minutes, in both cases about $^1/_3$ less.

Conclusion

The results of this investigation seem to indicate that:

(1) Some fluorine is lost during the smelting of enamels but not all of it.

(2) The longer the duration of heating the greater will be the amount of fluorine volatilized from the smelt regardless of the form.

(3) The higher the alumina content present the less the loss of fluorine.

(4) It is incorrect to assume that the fired weights and the raw weights of either cryolite or fluorspar are the same.

New York State School of Clayworking and Ceramics
Alfred, N. Y.

NEW METHOD OF DIRECT FIRING GLAZED CERAMIC BODIES[1]

By F. A. Whitaker

ABSTRACT

A description is given of the construction, operation, and economies of an adaptation of Carboradiant principle of heating to a rectangular kiln used for firing sanitary ware. Improvement in control, increase in first quality ware, and economy of fuel resulted.

Introduction

As manufacturers of heavy pieces of vitreous stoneware, the desirability was realized early in the year 1924 of discovering some improved method of firing the large rectangular direct coal-fired downdraft kilns that were then in use in our plant. It was necessary to eliminate the heavy labor involved in firing these kilns with coal along with the necessity of maintaining expert supervision of every run and to employ a method of firing that would permit the close duplication of and adherence to a definite firing schedule together with a more positive control of the kiln atmosphere.

After carefully considering the merits of producer gas, pulverized coal, and oil as fuels, the latter seemed to offer greatest possibilities with minimum outlay for equipment.

Some years previously an attempt was made to convert these large coal-fired kilns to oil by equipping each fire box with an oil burner and introducing the oil fuel into the existing fire boxes. This attempt was unsuccessful[2] in that it increased costs and did not provide the uniformity of conditions or quality of ware desired.

Small Kiln Trial

Having observed the operation of enameling and heat-treating furnaces equipped with combustion chambers of the so-called radiating type, it seemed a logical step to apply this method of burning oil fuel to ceramic kilns, and so it was decided to equip a small kiln for experimental purposes with this type of combustion chamber.

The Combustion Chamber

The radiating type of combustion chamber is a comparatively new development and is sold under the trade name "Carboradiant." It is constructed of silicon-carbide shapes and tile, and consists of a combustion tunnel of one or more passes which is built within the furnace or kiln and adjacent to the walls. This type of combustion chamber need not be

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Terra Cotta and White Wares Divisions.) Received December 18, 1928.

[2] F. A. Whitaker, "Oil Firing of Kilns," *Jour. Amer. Ceram. Soc.*, **3** [10], 842 (1920). This method of firing is described.

tied in with the brickwork of the kiln structure and is, therefore, readily accessible for repairs when necessary.

In the form that was first employed, the combustion chamber consisted of two passes, one placed above the other. The chamber was about 8 feet long, 2 feet high, and 1 foot wide. The cross-section of each passage was 9 by 9 inches. The lower pass, into which the oil fuel was burned by means of a burner especially designed for the purpose, was without ports except at the end opposite to the burner where all of the burning gases were delivered to the upper pass, and in which their direction was

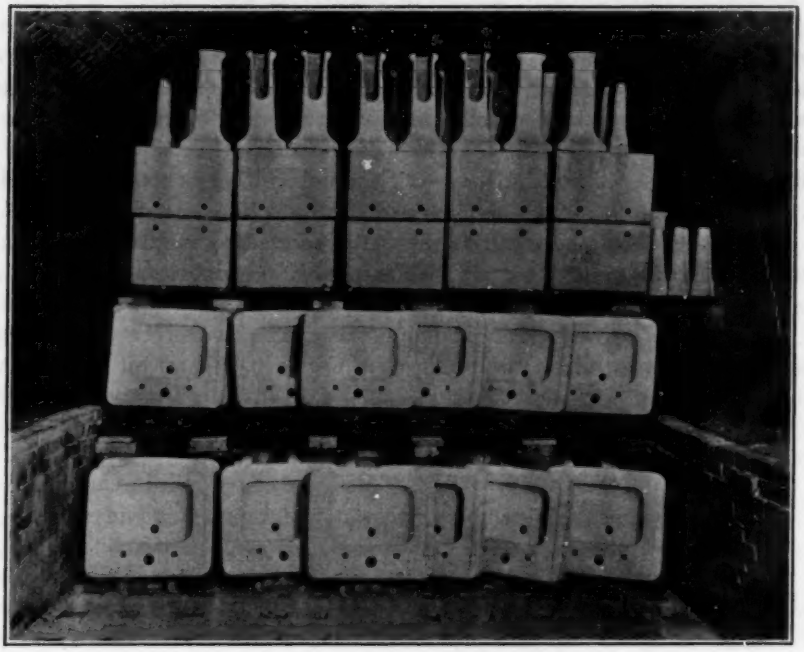


FIG. 1.—Interior of sanitary-ware kiln.

reversed toward the front of the kiln. This upper pass was provided with ports or slots in the top through which the products of combustion were admitted into the kiln chamber. The desired distribution of the products of combustion into the ware chamber was accomplished by varying the position and size of the ports in the top of the upper pass.

Heat Radiation Being constructed of silicon carbide, a refractory material possessing exceptional ability to conduct and radiate heat, some of the heat of combustion is delivered to the ware within the kiln in the form of radiant energy from this type of combustion chamber. This heat release through the walls of the combustion chamber

relieves the refractories from what would otherwise be a destructive temperature within the combustion chamber, and this fact coupled with the super-refractory properties of the silicon carbide, results in minimum maintenance and long life of the combustion zone of the kiln.

The heat release through the walls of the chamber also permits the complete combustion of larger quantities of fuel than would otherwise be possible. This has been demonstrated through attempts to employ refractories of lower thermal conductivity in similar constructions and at similar rates of combustion, with the result that such refractories have been destroyed within a comparatively short period of time.

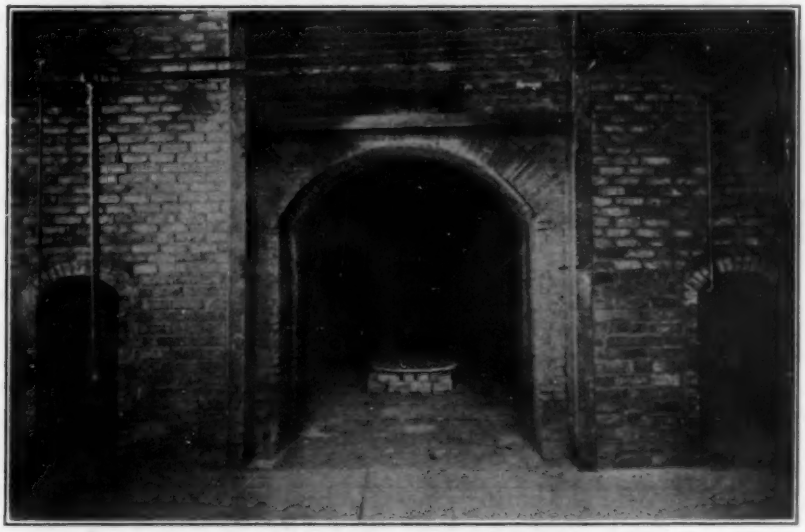


FIG. 2.—Outside of stoneware kiln.

Combustion Distribution

The intimate contact of the burning fuel with the radiant walls of the interior of the combustion chamber and the burning of the fuel within elongated passages of comparatively small cross-section result in a completeness and control of combustion which is not readily secured with other methods.

The products of combustion continue to rise after leaving the ports in the upper pass of the combustion chamber and proceed thereafter to follow the usual course of the gases in a downdraft kiln with the added advantage of being distributed in a manner that promotes an extreme evenness of temperature of the ware from end to end of the kiln. The openings in the top of the chamber are spaced approximately twelve inches apart and produce the effect of firing with a number of small burn-

ers. Generally, the gas openings are larger toward the two ends of the kiln to offset door and end-wall heat losses.

The first installation was made in a small rectangular kiln with inside dimensions 12 by 12 feet. Within this kiln were placed two Carboradiant chambers of the size and construction described above, one being placed along each side of the setting space. These chambers replaced four coal fire boxes which were simply bricked up at the time of conversion.

The results obtained in this small installation appeared to justify the conversion of a large kiln having an inside floor area of 44 feet by 15 feet. This kiln had previously been fired by means of twelve coal fire boxes arranged six on each side.

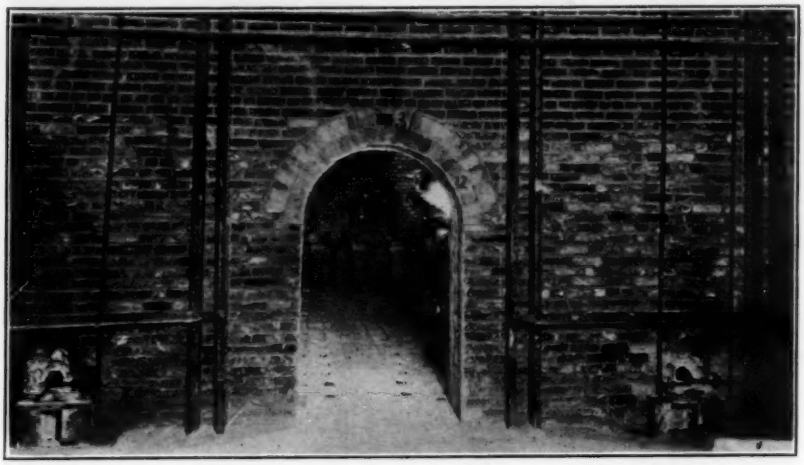


FIG. 3.—Outside of sanitary ware kiln showing burners.

Large Kiln Trial

In this larger kiln four Carboradiant chambers were employed, two on each side which were fired from opposite ends. These chambers were larger than those employed in the small kiln, having an outside dimension of 22 feet in length, 35 inches in height, and $13^1/_2$ inches in width. The upper and lower combustion tunnels had an inside cross-section of $10^1/_2$ by $12^1/_2$ inches and in this case the lower passages were separated by a duct through which air was admitted at the end opposite to the burner and delivered to the burner in a preheated state. The purpose of air cooling the partition between the upper and lower passage was mainly to guard against the over-heating of the refractories that are entirely within the combustion chamber, which would otherwise not be able to dissipate heat by radiation.

The introduction of this air duct, moreover, provided preheated air which has been found highly desirable as a further means of accelerating combustion and of effecting the control of the kiln atmosphere.

Positive Control This larger installation also proved highly satisfactory from the standpoint of easy operation and control of temperature and atmosphere within the kilns. The labor saving apparently offset the increased cost of oil fuel as compared with gas-coal, and it is now possible to adhere to an exact firing schedule with ease and to vary the kiln atmosphere from oxidizing to reducing at will. Any desired set of conditions can be maintained over any length of time by means of simple adjustments of the burners and the observation of the products of combustion as they leave the combustion chamber.

This positive control of the kiln atmosphere is impossible with direct firing kilns with coal and a close adherence to a definite firing schedule with such fuel is possible only with expert supervision.

Fuel Economy The Carboradiant method of firing generates the heat within the kiln and immediately adjacent to the ware, so that none is wasted in heating massive firebox masonry as is the case with all other investigated methods of utilizing fuel oil in ceramic kilns that provided anything like the control of kiln atmosphere that has been secured here.

Improved Quality Through the employment of this method of direct firing kilns with oil a distinct improvement has been effected in the quality of the ware, and glazed vitreous bodies have been produced of a quality which cannot be duplicated in an open-fired coal kiln.

Advantages Summarized

(1) Simplicity of Design The general construction of the kiln can be materially simplified when this principle is used. As compared with coal firing, all fire boxes, grate-bars, and fire doors are eliminated and the massive masonry of the kiln side walls incident to the use of fire boxes is made unnecessary. This is also relatively true when comparison is made with a kiln design suitable for use with other oil-firing systems employing large numbers of burners.

The savings resulting from the simplification of the general kiln design would about offset the additional cost of the silicon-carbide refractories required for the construction of the Carboradiant chambers in the case of a new kiln designed to employ this method of firing. The cost of this is therefore no greater than that of a kiln provided with a number of fire boxes.

(2) Repairs Fire-box repairs and grate-bar replacements, the two heaviest items in kiln maintenance when firing with

coal, are entirely eliminated. These items alone would probably offset any repairs which may eventually be required in the Carboradiant combustion chambers. Through this method of firing the life of the refractories of the general kiln structure should be greatly extended, because all of the burden of combustion is placed upon the silicon-carbide chamber which in itself is entirely uninsulated. As a result the heat developed within the chamber is so readily dissipated that the effect of the conditions encountered is much less severe than that on the lining of a typical fire box, which with its outer masonry is well insulated.

(3) Quality of Ware The positive control of firing conditions results in a more uniform quality of finished product. Through the elimination of ash the appearance of the ware is improved and it is made possible to direct-fire glazed ware which otherwise could be satisfactorily fired only in a muffle kiln.

(4) Labor Saving The heavy labor operations involved in the handling of coal and ashes and the cleaning of fires are eliminated, and due to the simplicity of operation the services of highly trained firing experts can be dispensed with. These savings are of material importance and through their accomplishment the use of a more expensive fuel with consequent cleanliness and ease of operation is justified.

The fact that a maximum of only four burners is required to fire the Carboradiant kiln makes it possible for one operator to attend a greater number of kilns and facilitates ease of control.

(5) Fuel Economy While the actual fuel costs when firing with oil by this new method do not show a saving when compared with the results obtained from a direct-fired coal-burning kiln of similar dimensions, there are many operations which have heretofore necessitated the employment of muffle kilns that can now be direct-fired by this new method, with a marked saving in the cost of fuel employed. If the comparison is made between a direct-fired and muffle kiln where oil is used as a fuel in both cases, the resultant savings are quite startling. This is readily realized when the heating efficiency of a direct-fired kiln is compared with that of a muffle kiln.

Data on Firing

The data in the following paragraphs have been taken from a survey made by the A. C. Nielsen Company of Chicago, covering the operation of thirteen direct-fired Carboradiant kilns used in the manufacture of high-grade vitreous and glazed fireclay sanitary ware.

The plant now employing these kilns built the first one in 1926 to increase its plant capacity. Only muffle kilns had been used prior to that time since it had been found necessary to protect the ware from the

products of combustion even when firing with oil by any method tried previous to the development of the Carboradiant principle. The final design of the kilns now employed is the result of coöperative study and experimentation.

It has been proved that the gases leaving the combustion chambers in these new kilns are not harmful to the ware, and that the advantages in time saving and fuel costs of direct-firing can be obtained along with a reduction in spoilage and an improvement in the general quality of the finished product.

The kilns in question are rectangular, measuring 12 feet by 30 feet inside and are about 10 feet high. A door large enough to permit entry and loading is provided at one end and is built up, after loading, with 9 inches of brickwork. The Carboradiant chambers are placed lengthwise of the floor, two on each side. The ware fired is of all shapes and sizes, including bath tubs, basins, sinks, and other sanitary shapes and no attempt is made to load pieces of one kind.

In this kiln it has been found advantageous to use screen walls between the combustion chambers and the ware to reduce direct radiation. These are built of fire brick four and one-half inches wide to the height of the combustion chamber. In other operations such walls have not been found necessary.

The use of screen walls and the type employed, whether solid or perforated, high or low, depend upon the kind of ware and the manner of setting.

The heat is brought up gradually to 2400°F and the kiln cycle is approximately $8^1/_2$ days, 100 hours of which are required for heating and 4 to 5 days for cooling.

The kilns previously used were of the round muffle type, the inside dimensions being 20 feet in diameter with walls 9 feet high and a spherical roof rising 6 feet in the center. The muffle was built of fireclay brick and the burning gases were passed around this muffle through flues from 14 oil burner ports or fire boxes. Only the heat which passed through the firebrick muffle was utilized in heating the ware.

These round muffle kilns held practically the same amount of ware as the new rectangular kilns. They were heated up to the same temperature and required approximately the same number of hours for cooling. The firing cycle, however, was 120 hours in place of the 100 hours required with the new kilns. Due to the quicker heating and the shorter time required to prepare the kiln for firing, an average increase of one-half heat per month has been obtained from the new direct-fired kilns as compared with the old type of muffle kiln. In other words, two and one-half heats are secured from the new kilns as compared with two heats from the old. With equal loads per charge this represents an increase of 25%

or 6 heats a year, an increase in output equivalent to that obtained from one of the old type of kilns in a period of three months.

The direct firing and the resulting shorter firing period is showing a marked economy in fuel. The old kilns required an average of 3700 gallons of oil per firing. The new kilns are consuming 2700 gallons per firing. This economy is attributed to the kiln design and combustion method. The same oil burner as previously employed is used on the new kilns. This is of the high-pressure air-atomizing type, the air being supplied at 24 pounds per square inch, and the oil at 18 pounds per square inch pressure, without preheating.

The circular type of kiln was wasteful of floor space, requiring an area of 34 square feet to allow for passage between kilns. The new kilns are placed in pairs with passages between each battery of two kilns. The floor space required per kiln is now 810 square feet, as compared with 1150 square feet for the old kiln. This represents an average of 29% saving in floor space for the new kilns as compared with the old, the space saved being utilized for storage. Considering both increased number of heats and reduced floor space, the output per square foot of floor space has been increased by 77%.

The cost of this type of kiln is estimated by the user to be approximately $8000, and since an annual saving in fuel costs, etc., of slightly over $4000 per kiln has been effected it is obvious that this return is sufficient to pay for the kiln in a period of two years with no sacrifice in quality. If any quality difference exists, it is in favor of the new kiln.

Stated in another way the adoption of this new type of kiln for the purpose of firing a glazed ceramic body which previously was fired in a muffle kiln has resulted in a reduction in firing costs of 34%. In reaching these figures an average life of five years has been estimated for the combustion chambers as compared with the life of six years for the fire ports and inner walls of a muffle kiln.

The company that first experimented with the Carboradiant kiln in the manufacture of glazed sanitary ware is so well pleased with the results secured that thirteen kilns of this design have been built within the two years following the initial installation and it has been found economical to dismantle a number of round muffle kilns that were in first class condition to make room for the new type.

While it is not the purpose of this paper to imply that all grades of glazed ceramic ware can be fired successfully in this new type of open-fired kiln, or that muffle kiln operations are not required for the more delicate glazes on fine chinaware, the results obtained to date indicate clearly that the majority of heavy, glazed ceramic articles can be successfully and more economically fired in the Carboradiant kiln. For instance, it has been demonstrated in numerous tests that terra cotta even in the

more delicate colors, with the exception of reds and golds, can be successfully fired in this kiln, and up to the present time it is understood that the Carboradiant kiln has also been used for firing electrical porcelain, faience tile, and carbon brushes.

In conclusion it is believed that the Carboradiant method of firing provides an extremely satisfactory means of delivering the products of combustion to a ceramic kiln, since it is possible to secure uniform distribution of heat and gases throughout the length of the kiln in contrast to the alternate hot and cold spots characteristic of the conditions secured when fire boxes are employed. It has been demonstrated that a remarkable uniformity of temperature throughout the kiln chamber can be secured if the bottom and the flue outlets are properly designed, and the kiln is loaded in a manner that will promote the correct circulation and prevent the pocketing of the hot gases.

General Ceramics Company
Keasbey, N. J.

A TUNNEL KILN REFRACTORIES PLANT[1]

By B. E. Whitesell

ABSTRACT

A description of the Salina Plant of the Kier Fire Brick Company, where all the ware is fired in two hand-fired, car-tunnel kilns. Some of the steps taken in changing the old plant to the new, the present plant layout, the method and procedure in the manufacture of the different shapes, capacities of the machines, etc., are described.

When the question of tunnel kilns came up at the Salina Plant, Kier Fire Brick Company, many engineering problems presented themselves, due to the location of the plant. With a hill on one side and the railroad and river on the other, expansion was limited. (See Fig. 1.) It meant that the new part of the plant had to be located on the present site. Production had to be kept normal, which required the use of all the present

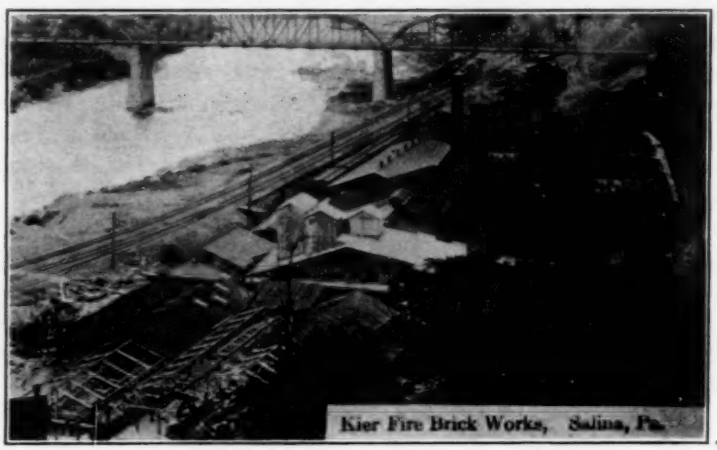


Fig. 1.

kilns; furthermore, since this was the first kiln of this type on fire brick in this country, it was deemed advisable to keep all the kilns until the tunnel kiln had been given a trial.

The first tunnel kiln was placed directly over the siding next to the hill, keeping it as close to the hill as possible in order to gain some room and putting the new floor level approximately thirteen feet above the old level, making the new level safe from high waters, from which the old plant had suffered much loss. This also made the railroad sidings the same level as the main tracks.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill. February, 1929. (Refractories Division.) Received December 1, 1928.

Figure 2 shows the location of the building in which the first kiln was housed and later on the second kiln. The kiln was set on a reinforced concrete slab supported by reinforced concrete columns. Some difficulty was encountered at times in getting footings for the columns as it was necessary to go down through old coal workings and slides. The concrete slab was made just wide enough to accommodate the kiln and a temporary timber trestle, which extended part way over the old kilns, was used for setting and unloading the kiln cars, as it was not desirable to move the kiln cars from one level to another. The steel for the building was put up by moving a jin pole along on the kiln foundation.

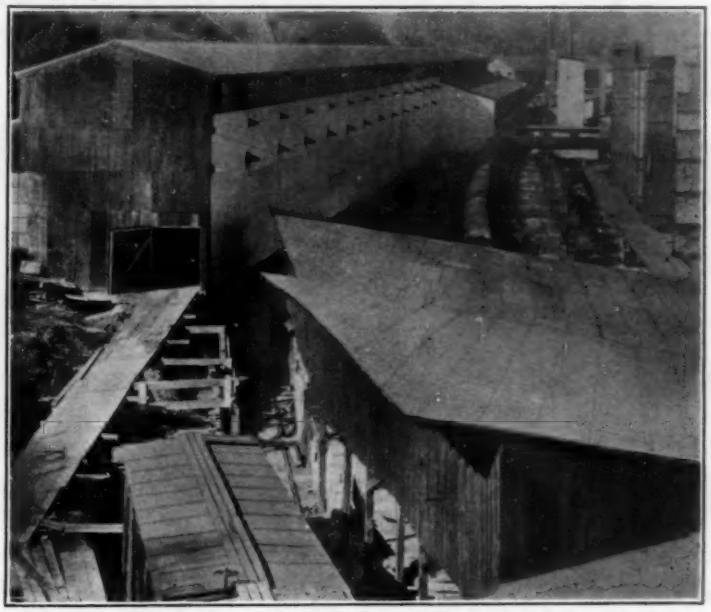


FIG. 2.

An electric elevator of 6000 lbs. capacity, installed in the cooling zone of the old tunnel driers, brings the drier cars with green brick up to the new level. This elevator handles everything except the dry-press nine-inch and shapes. The brick were wheeled down to the old level.

When the first kiln was in operation, half of the rectangular kilns, or one row, could be eliminated. The filling in with furnace slag, on this part of the fill, was done with a crane and grab-bucket. Furnace slag was used entirely in the fill, being placed in layers, each layer being watered and tamped. Holes were knocked in the crown of each kiln and the kiln filled with slag, leaving the kilns standing as they were. As the filling

progressed and room was made, the shapes from the storage and the two railroad sidings were brought up to the new level. The filling continued until the remaining kilns were surrounded on three sides by the fill. A temporary elevator was used to bring the fired brick from these kilns up to the new level.

Number 2 kiln was placed beside No. 1 kiln as shown in Fig. 3. The coal and ash handling, the collecting of the waste heat, and the supervision were all simplified by this arrangement. The second kiln was made seventy-five feet longer than No. 1, because the furnaces could not be placed opposite each other on account of the coal storage and working conditions. The extra seventy-five feet were put on the heating-up end of No. 2 and made it more suitable for clays which required slower heating up. Part of the foundation for this kiln rests on the old kilns and part is on columns brought up from the old level.

FIG. 3.

Since both kilns were turning out brick at this time, the rest of the rectangular kilns were filled with slag. There were about 450 cars, or 24,000 tons, of furnace slag used in the entire fill.

The rest of the building was then put up, using a crane. Figure 4 shows the building as it is at present. The building for the new part of the plant is composed of three units, each unit having its own monitor. The unit over the kilns is 493 feet long, 50 feet wide, and 13 feet high from floor to the bottom of trusses. The unit adjoining this is 615 feet long by 71 feet 4 inches wide. There is next a flat section, triangular in shape and 48 feet 8 inches wide at the wide part. The last unit is 453 feet long and 47 feet wide. This makes the entire building 217 feet at the widest point and puts all the work inside the building, which can be closed tight in winter.

The flat section was designed to gain room since it allowed the last section to be put up parallel to the railroad, which is not parallel to the

kilns. These last units have a height of 22 feet from railroad rail to truss, or 18 feet from floor to truss. All roofing and sides not of brick are covered with asbestos-protected metal, except the flat section, which has a roof of concrete slabs with a built-up section on top of this. The entire floor area (98,000 sq. ft.), except the railroad pits, is of reinforced construction with all edges protected by angle iron.

The concrete deck for the setting and driers was placed directly over the old tunnel driers, the steel columns passing down through the partition walls of the driers, thus giving use of all the tunnel driers.

For several reasons, it was decided that the most economical layout would be to place a railroad siding on each side of the building. Next

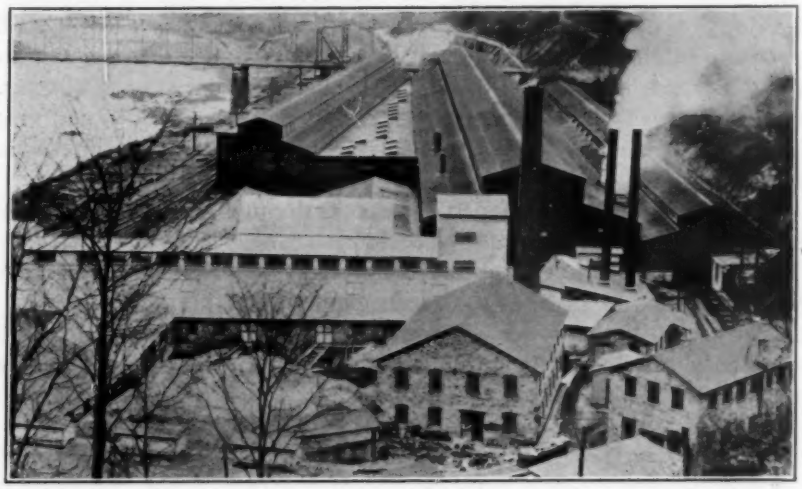


FIG. 4.

to each siding, which has a 14-foot pit, an 8-foot wheelway was put in. This gives ample room for something other than wheelbarrows, if, in the future, some other method of handling fired brick should be desired.

The two kiln car return tracks where the brick are unloaded come next. Between these two tracks is the storage. In making this layout the idea that the kiln cars should make the complete cycle with the least possible movement was kept in mind. It has not only accomplished this, but it has made wheeling distances short and gives a chance to spot and hold cars for a time, often saving a second handling. These are some advantages that could not have been obtained with one long return track. The main objection to the two return tracks was the fact that a bridge or cross-over had to be used over one of the railroad sidings for the transfer. This has not proved a serious factor, since the trolley

bridge and wheeling bridge are counterweighted so that one man can easily handle them, while the bridge carrying the track for the transfer is raised and lowered by an electric hoist. This motor is push-button controlled with a limit switch and self-locking drum.

The level of the floor around the kilns and on the drier deck is the top of the kiln car rail, while the floor of the railroad cars, the top of the kiln cars, wheelways, storage, dry presses, and setting decks are all on the same level.

Equipment and Process

Clay Preparation All clay and grog pass through a jaw crusher located under the railroad track hopper. It is then elevated by a bucket elevator to an overhead conveyer, which distributes it to storage bins by means of a movable tripper. From the bins it is fed to the dry pans by disk feeders on the bottom of each bin, each pan being provided with three bins for hard clay, plastic clay, and grog.

All four pans are inclosed and a dust collector keeps the room clean at all times.

Three of the pans are driven by electric motors and tex-rope drives, each drive having ten ropes.

From the pans the clay is taken by bucket elevators to the screens. At present two of these elevators are equipped with traction wheels, a smooth wheel with no teeth, in place of a head sprocket. From the screens the clay is taken to a double shaft pug mill where it is tempered with water. A poidometer with liquidometer attachment, which controls the amount of clay and water going into the pug mill, is used.

After passing through the pug mill, it is taken to the mixers over the dry presses by a 12-inch conveyer. This conveyer, with a total length of 220 feet, is composed of four conveyers on account of the different angles it makes in going from the old building to the new. It is all driven from the front end, that is, one belt, through its tail pulley, drives the head pulley of the belt back of it through gears and sprockets.

Up to this point five men are required to handle the clay.

By means of gates the clay is distributed to the different mixers. These mixers have revolving plows which keep the clay fed to the boots leading to the presses and also keep it from packing. This belt conveyer, the mixers, and presses are all driven from a 175 H.P. synchronous motor with push button control.

Presses Three presses are in use at present as shown in Fig. 5 with provision made for the fourth. Each press has a capacity of 16,000 9-inch brick per eight hours. All work is done in eight hours, extra brick being set in this time to take care of the other sixteen hours and week-ends.

Kiln Setting In setting the brick from the presses, the men stand on the kiln cars and since the presses are as close as possible to the kiln cars and one man sets ahead of the other, no extension is needed on the press table. Two men set from each press. The kiln cars, during the setting, are kept in a solid string, being moved by a chain conveyer, a dog on the chain engaging the last car only. This conveyer has two speeds, one ten feet per minute and the other ten feet per hour. The slow speed is set so that the relation of the setting space is always the same to the presses. In this way it is not necessary for the machines to stop or the setters to change their positions.

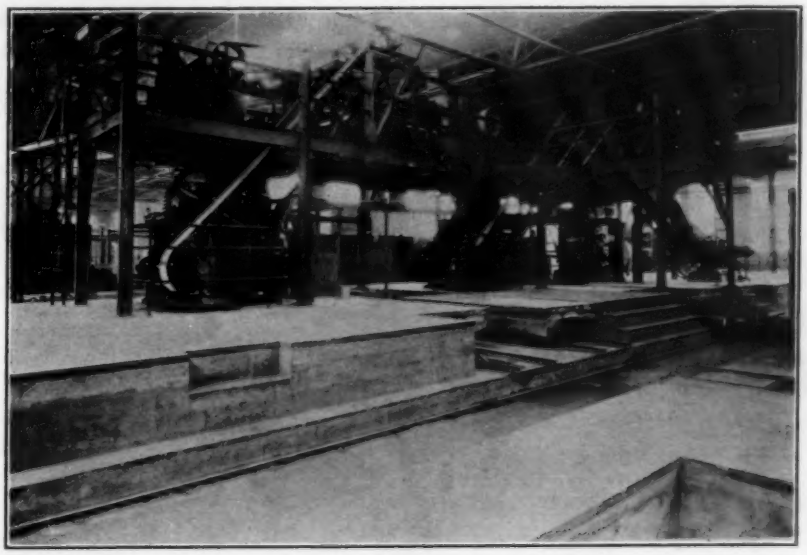


FIG. 5.

Since hand-molded shapes and power-press shapes are also made, it is necessary to top out dry-press cars or to set solid cars with these shapes. The three presses and all shapes are taken care of with eight men. Each press has its own kiln car track, making it independent of the others. Figure 6 shows how the shape setting is done. Solid cars of shapes, cars topped out and with straight 9-inch can be seen. The brick are set three on one, twelve courses high, with each car divided into four blocks. The cars are six feet square and hold 1350 brick with the setting used at present.

Handmolded Shapes Handmolded shapes 18 inches and under in length and 3 inches in thickness are put on rack cars, instead of the hot floor, saving space and handling. All other handmolded shapes are put on a hot floor. These shapes are put on steel

pallets, being dumped on the pallet on a dumping table, then laid on the floor. This eliminates crooked tile due to floor unevenness and hard bumping when the molds are dumped directly on the floor. It also allows the men to work in more comfortable positions. The power-press shapes are made on a soft-mud machine, semidried in a drier on rack cars and pressed in power presses. A total of 12,000 9-inch equivalents is made by these methods, making a total of 60,000 brick per day for the plant. One man is required part time to bring these shapes up to the new level.

Drier Since the cars are loaded on three tracks and sometimes topped out on a fourth, a transfer is required at this point as a two-track drier is used. The cars are moved from the setting position into the drier by means of a motor winch and cable.

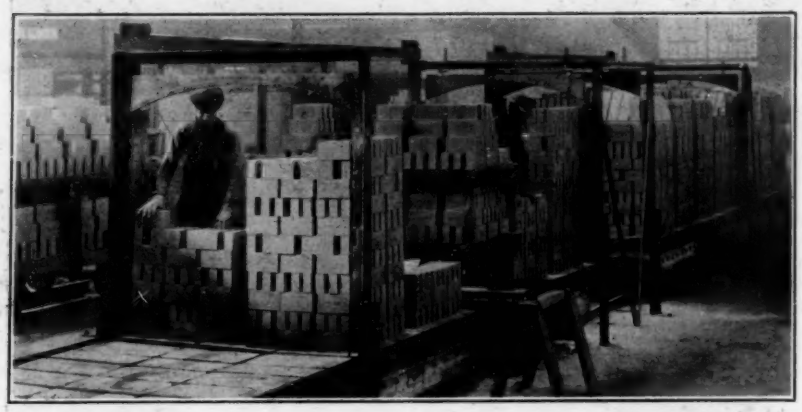


FIG. 6.

Due to the different methods of manufacture and shapes made at this plant, it is impossible to have a simple layout such as is used where only one product is made.

The Harrop drier has two tracks, the total length being 135 feet and the width 16 feet 2 inches. It is heated with waste heat from the cooling ends of the kilns, which is brought from the kilns by means of an underground duct located between the kilns. One fan on the drier with a capacity of 25,000 c.f.m. located at the discharge end of the drier furnishes more heat than is really needed for drying at present. A fan located on this deck puts waste heat to all the driers in the old plant.

There is also a single-track drier or preheater on this deck. At present it is using products of combustion for drying. The temperature of these gases leaving the kiln is about 350°F. The preheater is operated by dampering off one stack, sending the gases through the preheater and

out another stack at the opposite end. The air ducts are arranged so that clean air, products of combustion, or both can be used in either place. There is one open track on the deck, and provisions for another, and so arranged that these two tracks can be made into a drier if desired.

The cars on these five tracks are moved by a rope puller. The puller has a shaft running the entire width of the deck with a drum and jaw clutch at each track. It is the same type as used in the old tunnel driers, except that it is much heavier. It moves the cars 12 feet per minute. The loaded cars are taken from these tracks and put on an electric transfer, the cars being pulled by a drum on the transfer at a speed of 90 feet per minute. The transfer travels 150 feet per minute. From the transfer the cars are put in the kilns.

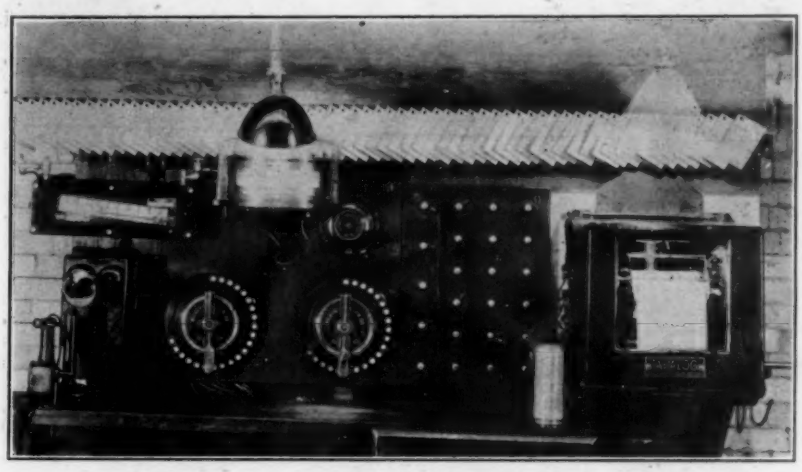


FIG. 7.

Kilns A hydraulic ram pushes the cars through the kiln, requiring about 1000 lbs. pressure per sq. in. The ram travels the length of a car, then automatically returns to its original position. The cars move forward at such a speed as to give time for the return of the ram which requires from four to five minutes. The speed is controlled by a variable speed transmission and depends on the schedule, which may be anywhere from one to three hours.

The kilns are hand fired, Harrop car-tunnel kiln type, using run-of-mine coal. No. 1 kiln is 376 feet 6 inches long, holding 62 cars and No. 2 is 452 feet 3 inches long, holding 75 cars. The inside width of each kiln is 5 feet 8 inches.

No. 1 kiln has six furnaces on each side, while No. 2 has seven on each side. The furnaces on one side alternate with those on the other side.

There are two fans on each kiln, the air supply fan putting cold air into the discharge end of the kiln to cool the brick, into the double crown which supplies heated secondary air for combustion, into the side walls of the furnaces where the air is heated and used for primary air for combustion, and under the cars to keep the metal cool. The other fan, the exhaust fan, takes out the products of combustion.

The time for firing and stirring is controlled by a master clock which blows a horn indicating that it is time to fire one side of the kiln and stir the other side. Ten minutes later a bell will ring and the fireman that stirred will now fire and the other fireman will stir. From one to one and one-half shovels of coal are put into each furnace every twenty minutes.

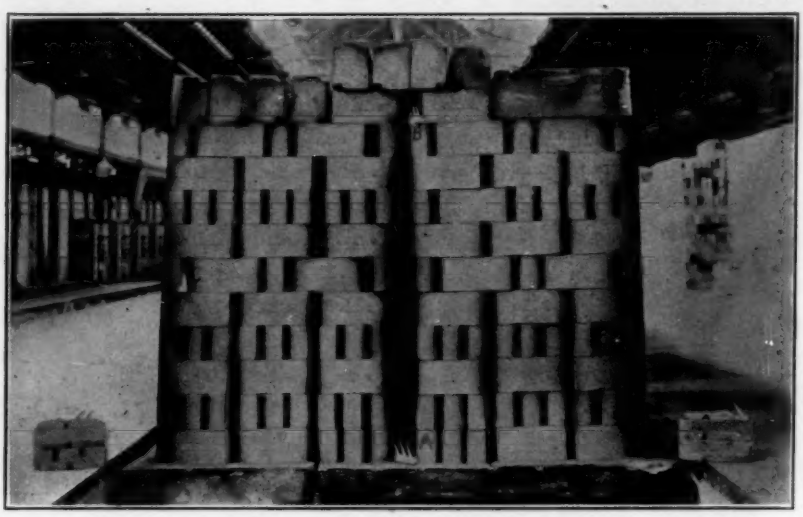


FIG. 8.

The fires are cleaned each shift of eight hours, but the cleaning is spread out over most of the shift. Every other furnace is cleaned with the men beginning at opposite ends. They then come back and get the other furnaces. By this method very little temperature change takes place at any time.

These two men take care of the entire kiln. They also bring the brick from the driers and put them in the kiln and take the fired brick from the kiln and place them for unloading.

All temperatures in the kiln are put down each hour. This gives the men a check on the temperatures from hour to hour. Figure 7 shows the controlling instruments, an indicator and six-point recorder, a differential draft gage, position and description of the material going through the

kiln, and the location and number of thermocouples. Cones are used as a check against the pyrometers. The cones on the car in Fig. 8 show the position of the cones during firing and as can be seen, give the extreme conditions. The cones to the right of the car show a cone 13 fire, while those on the left show a cone 12 fire. This gives an idea of the uniformity of the firings, the right hand cone on each cone pat being cone 13.

The cars are taken from the kiln by an electric transfer the same as at the charging end of the kiln and placed on either of the return tracks by a rope puller, which is controlled by three wires running the entire length of the unloading deck and located in the pit beside the kiln cars. From here the brick are taken to the railroad cars or storage by wheelbarrows, the wheelbarrows being equipped with Timken roller bearings and rubber tires. This, and the fact that the brick are not touched after

FIG. 9.

they are set on the kiln cars at the presses has greatly reduced the breakage and bad corners. Of course, setting the brick only twelve courses high has reduced the breakage and kiln marking. After being unloaded the cars are moved up to the end of the unloading track where they are cleaned of sand and oiled. They are now ready to be transferred to the presses.

The coal is brought directly from the mine to the kilns in the mine cars and stored beside each kiln.

Incidental Layout

The office is located in one end of the building and contains six rooms and laboratory. It can be heated by steam or waste heat from the kiln.

A fourteen-car, fire-proof garage, which is heated by gas, is also available to the men.

The new part of the plant is entirely separated from the old part by a $13\frac{1}{2}$-inch fire wall, fire doors, and $\frac{1}{4}$-inch wire glass windows.

The storage (Fig. 9), is laid out so that every shape has a definite place with no space wasted, except for the cross-aisles which lead from one loading deck to the other.

Cool air is supplied to the firemen in warm weather by a fan which pulls cool air from the clay mine located under the plant.

The lighting is well taken care of with 300-watt lamps, while the railroad cars are lighted with extension reels. All wiring in the plant, except feed lines, is in conduit.

The problem of cleanliness is being carried out with the coöperation of every man. Containers are placed at all vantage points. All departments are cleaned daily, the machines being stopped fifteen minutes before quitting time and cleaned. It has proved well worth the effort, because good labor can and will do still better and will enjoy work more with clean, well-lighted surroundings.

THE KIER FIRE BRICK COMPANY
PITTSBURGH, PA.

A COMPLETELY AUTOMATIC DECORATING TUNNEL KILN[1]

By John T. Jans

ABSTRACT

A continuous decorating kiln is described which is completely automatic in temperature control and ware movement. This paper deals chiefly with the automatic ware movement, which is achieved by mechanical operation of the two four-way valves, through which oil is supplied to ten hydraulic cylinders which open and close the doors, move the transfer cars on each end of the kiln, and move the ware cars through the kiln and down the loading track. An electric repeating contact clock determines the schedule upon which the kiln operates.

Introduction

In the fall of 1927, three completely automatic decorating tunnel kilns were put into operation at the plants of three of the largest potteries of the East Liverpool district. These kilns were the first to be automatic in operation of ware carriers as well as in control of temperature. The success of this development resulted in the construction of four additional kilns of this type during the past year.

Temperature Control

The automatic control of the temperatures, at certain predetermined points in the ware tunnel, was a feature on the decorating kiln installed in Plant No. 6 of the Homer Laughlin China Company at Newell, W. Va., in 1923.[2] On more recent installations the automatic control of temperature has been improved by increasing the number of points of control and simplified (on natural gas installations) by single valve control in which only the air required for combustion is controlled. Figure 1 shows the automatic pyrometrically controlled valves in the combustion air lines. Each valve controls two burners. There are four control points on the kiln.

Automatic Movement of Ware Carriers through Kiln

The placing and drawing of ware is the only labor chargeable to the kiln other than the usual maintenance service, such as oiling of cars once per week, adjustment of instruments, etc. Figure 2 shows a ware car loaded with fired ware being transferred from the discharge end of the kiln to the return track.

The movement of the ware cars is accomplished by means of a series of hydraulic cylinders in which oil is the operating fluid. The rams of these cylinders are moved forward or returned by the pressure of the oil

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received December 14, 1928.

[2] See "Operation Data on Continuous Decorating Kiln," *Jour. Amer. Ceram. Soc.*, 7 [8], 626–29 (1924), for brief description of this development.

against the heads of the rams in proper order to complete the cycle of operation. A motor driven pump supplies oil to two four-way valves which, in turn, direct the flow of oil to the proper cylinders and in the proper direction to accomplish the movement of the ware cars in the desired direction.

One of these four-way valves supplies oil to the kiln cylinders, six in number, *i.e.*, two kiln doors, two vestibule doors, the main kiln ram, and a kicker ram which moves the car at the discharge end of the kiln independently on to the transfer car at that end. The other four-way valve

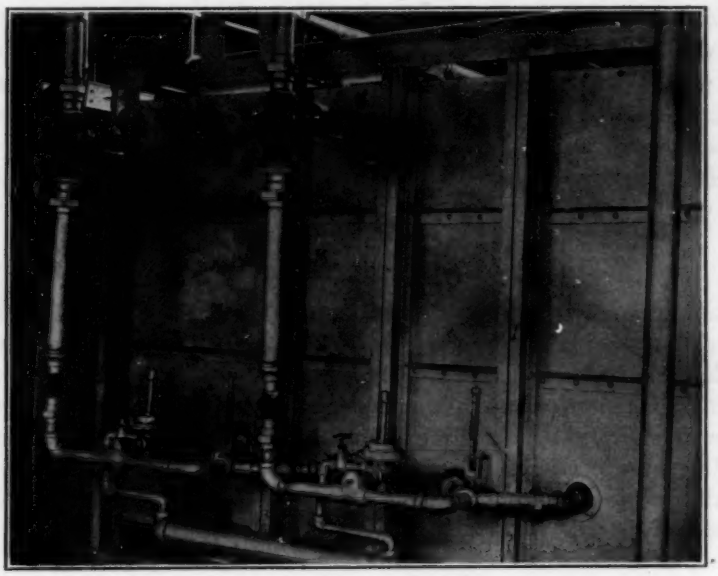


FIG. 1.—Automatic control on burner manifolds.

supplies oil to the four outside cylinders, *i.e.*, the two transfer carriage cylinders, the main puller on the return track and the kicker ram on the return track which moves one car independently from the return track on to the transfer car at the charging end of the kiln.

Cycle of Operation

The cycle of operation is as follows:

Starting position: Both transfers in vestibules, loaded transfer at charging end, empty transfer at discharge end.

(1) Vestibule doors close
Kiln doors open

Kicker and main ram forward, loading at discharge end and unloading at charging end transfer

(2) Kiln doors down
Kicker and main ram return
Vestibule doors open

(3) Transfers move to return track
Kicker and puller on return track move out loading charge end transfer

(4) Kicker and puller return unloading discharge end transfer, moving train on loading track ahead one car length
Transfers move to kiln vestibules completing cycle

This cycle is effected by changing the flow of oil through the four-way valves at the proper time. Originally the operator of the kiln did this

FIG. 2.—Ware movement from discharge end of kiln to return track.

manually and it constituted his chief occupation in connection with the kiln. By operating the stem of the four-way valves mechanically this work was made automatic and eliminated the operator entirely.

Figure 3 shows the control table from which the operations are controlled.

An automatically resetting clock at top of panel board makes a momentary contact at a definite time interval which governs the schedule upon which cars will be run through the various operations. The clock in this case is graduated in one-minute intervals from 1 to 24 minutes. For instance, if it is intended to operate on a 12-minute schedule the clock will be set at the 12-minute point and will make momentary contacts exactly 12 minutes apart. It could also be set for 10, 11, 13, 14, or 15 minutes. After contact the clock hand will automatically return to the starting point making another contact after 12 minutes.

Through a series of contact panels and hatchway switches small motors operate cams through reducer sets which, in turn, move the stem of four-way oil control valves back or forth, directing the flow of oil to the various cylinders and in the proper direction.

The system is electrically and mechanically interlocked in every possible way so that no operation can start until a previous operation has been entirely completed.

Suitable hand control is provided so that system can immediately be changed from electric to hand control, or *vice versa*.

A series of resistance valves in the oil lines causes certain cylinders to receive oil and operate only after other cylinders supplied from the same mains have operated.

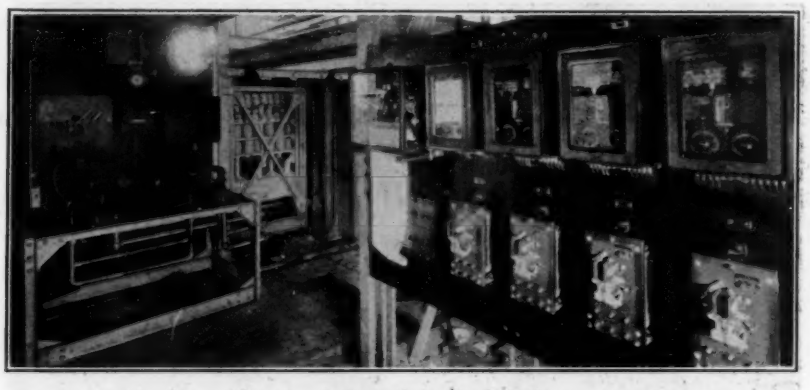


FIG. 3.—Automatic control station.

The stroke on the oil pump is adjustable, varying the volume of oil delivered per minute and, therefore, the time required for the cycle as desired. In operating the kiln on a 12-minute schedule the stroke of the pump would be adjusted so as to allow a cycle to be completed in 10 to 11 minutes, allowing a standby period of 1 to 2 minutes.

Advantages of Kiln

The chief advantage of this kiln is labor saving. In one case where one kiln was operating with manual control of car movements and another of equal capacity in an adjacent plant was operated with automatic car movement a consistent labor saving of $500 per month is being made.

The breakage due to ware jarred off cars is also slightly less than with manual operation.

In some cases the total firing cost of ware on the automatic kiln, including fuel, labor, maintenance, and repairs, has been as low as $0.02 per dozen.

HOLCROFT & COMPANY
DETROIT, MICH.

SOME LEADLESS BOROSILICATE GLAZES CONTAINING NICKEL OXIDE[1]

By H. H. Holscher

ABSTRACT

The literature pertaining to the use of nickel oxide in all types of glazes is briefly reviewed. A study of the effect of the various glaze constituents on the color and other properties of some leadless borosilicate glazes containing nickel oxide as a colorant is given. Nickel oxide has not proved useful in glossy non-opaque glazes. It is not recommended for use where a deep (dark) color is desired but can be made to produce very pretty opaque glazes, light tan in color and of a semimat character.

I. Introduction

There are several reports in the literature concerning the use of nickel oxide in glazes of various types but no paper deals specifically with the utilization of nickel oxide in leadless borosilicate glazes. It is the purpose of this paper to present the results of a study of this type of glaze. It was desired, mainly, to determine the effects of different RO constituents on the color of such glazes, and also to see whether the colors obtained could be relied upon under ordinary firing control.

Nickel oxide has been used in colored glazes but not very extensively except when incorporated with other coloring oxides. Its use alone in commercial glazes has been reported to give unsatisfactory results.

II. Review of Literature

The various papers upon the use of nickel oxide in the different types of glazes show that the many colors produced are due mainly to the differences in RO constituents in the glazes and their relative amounts.

Langenbeck[2] states that

> Nickel oxide itself is not used very extensively from the fact that in the more convenient glazes, which are rich in lead oxide and boracic acid, it is very liable to cause turbid loam-colored separations, and to shade badly from brownish to greenish tints. It is, however, serviceable in the more alkaline glazes and those poor in boracic acid.

Bourry[3] says that

> The oxide of nickel is scarcely ever used, because it gives uncertain and spotted shades, varying from yellowish green in alkaline glazes to dirty green in boracic ones, and brown-green in plumbiferous ones.

---

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Art Division.) Received December 14, 1928.

This investigation was undertaken in the preparation of a thesis to satisfy in part the requirements for the degree of Bachelor of Science in Ceramics at the University of Illinois.

[2] Chemistry of Pottery, p. 133.

[3] Treatise on Ceramic Industries, p. 412.

Furnival[4] would avoid its introduction in glazes whenever similar effects could be attained by other means.

Geijsbeek[5] reported that Le Chatelier and Champuy obtained violet, blue, green, yellow, red, and brown with nickel in oxidizing fire. Wicks and Mellor[6] obtained various shades of green, brownish green, and yellowish green as well as browns and blues. Ramsdem[7] gives a study of the solubility of nickel oxide in glazes.

Pence[8] obtained a shading of brown through to blue when he replaced BaO and CaO by ZnO in a cone 5 leadless glaze. Whitmer[9] reported that he obtained grays by the use of nickel oxide and about 0.15 to 0.20 equivalent MgO. He[10] also obtained various other colors including blues, browns, purples, and reds. Minton[11] gives glazes which have various shades of green.

In porcelain glazes Montgomery and Kruson[12] report that brown is the only color obtained and that variations in the RO did not affect the color.

In lead glazes, a recent class experiment[13] reveals that the colors obtained are dependent upon the RO variation. The basic glaze formula used was

0.14 KNaO
0.06 NiO
0.80 RO (variable)

0.35 Al_2O_3

2.65 SiO_2 (cones 1 to 3)

in which the RO variations and colors obtained were as follows:

0.80 PbO amber

0.30 PbO, 0.50 ZnO — slate blue

0.30 PbO, 0.50 CaO — cloudy brown

0.30 PbO, 0.50 BaO — purplish brown

0.30 PbO, 0.50 MgO — pea green

As these five extremes were blended with each other, the colors shaded one into another. Many shades were very pleasing to the eye.

A recently published table[14] is of interest in that many colors are reported.

Seger[15] gives the following limits for fritted leadless glazes:

0.6 KNaO, 0.4 CaO	0.5 Al_2O_3	4.0 SiO_2, 0.5 B_2O_3
	to	
0.2 KNaO, 0.8 CaO	0.6 Al_2O_3	5.0 SiO_2, 1.0 B_2O_3

[4] Leadless Decorative Tiles, Faience and Mosaic, p. 392.
[5] *Trans. Amer. Ceram. Soc.*, **6**, 195 (1904).
[6] *Trans. Ceram. Soc.* [Eng.], **13**, 61 (1913–1914).
[7] *Ibid.*, **5** and **6**, 8 (1905–1907).
[8] *Trans. Amer. Ceram. Soc.*, **14**, 143 (1912).
[9] *Jour. Amer. Ceram. Soc.*, **3**, 663 (1920).
[10] *Ibid.*, **4**, 357 (1921).
[11] *Ibid.*, **3**, 669 (1920).
[12] *Trans. Amer. Ceram. Soc.*, **16**, 356 (1914).
[13] In University of Illinois Ceramic Laboratory.
[14] *Keramos*, **6**, 343 (1927); also *Ceram. Abs.*, **7**, 123 (1928).
[15] Collected Writings, Vol. 1, p. 453.

Mellor[16] reports that the old type of leadless glaze had about the following composition and would not carry much more than 0.5 B_2O_3 without developing "milky" or turbid patches.

$$\left.\begin{matrix}0.45\ KNaO\\0.55\ CaO\end{matrix}\right\}\quad 0.35\ Al_2O_3\quad\left\{\begin{matrix}3.0\ SiO_2\\0.5\ B_2O_3\end{matrix}\right.$$

He also states that

$$\left.\begin{matrix}0.45\ KNaO\\0.55\ CaO\end{matrix}\right\}\quad 0.55\ Al_2O_3\quad\left\{\begin{matrix}3.5\ SiO_2\\1.2\ B_2O_3\end{matrix}\right.$$

maturing at cone 3a is not so troublesome as the older type but is not as reliable as the typical earthenware glaze. With an increased B_2O_3 content there is an inclination to blister.

Parmelee and Williams[17] give the following range of compositions as suitable for cone 7 sanitary ware:

$$\left.\begin{matrix}0.4\text{–}0.6\ KNaO\\0.0\text{–}0.3\ ZnO\\0.4\text{–}0.6\ CaO\end{matrix}\right\}\quad 0.5\text{–}0.6\ Al_2O_3\quad\left\{\begin{matrix}5.0\ SiO_2\\0.5\ B_2O_3\end{matrix}\right.$$

Montgomery's paper[18] is probably the best brief report of satisfactory leadless borosilicate glazes in general.

It is interesting to note that practically all the natural nickel silicates, usually hydrous, that are reported by Dana in his book, System of Mineralogy, are colored the various shades of green varying from greenish yellow on through to the darkest green. At least one has zinc as a constituent while most of them contain magnesium and some of them have small amounts of iron.

III. Experimental Work

As an introduction to the work it was deemed advisable to determine the most suitable alumina, silica, and boric oxide contents for the type of glaze that was desired. As a result three series of glazes were planned in which the RO was kept constant and the alumina, silica, and boric oxide all varied. The variations of compositions studied are shown in Figs. 1, 2, and 3 as are also the general results. The RO content was:

$$\begin{matrix}0.152\ K_2O\\0.048\ Na_2O\\0.350\ CaO\\0.450\ BaO\end{matrix}$$

The molecular relation between the K_2O and Na_2O (0.152 to 0.048) was chosen because it was the relationship which existed in the feldspar which was to be used. High BaO was used because it was thought that if it were all fritted, it would act similarly to PbO.

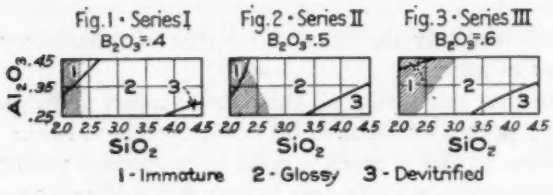
[16] *Trans. Ceram. Soc.* [Eng.], **12**, 7 (1912–1913).
[17] *Trans. Amer. Ceram. Soc.*, **18**, 812 (1916).
[18] Bur. Stand., *Tech. Paper*, No. 31 (1913).

Twenty-five thousandths (0.025) equivalents of nickel oxide were used and the analysis[19] of the material showed 99.25% NiO with no cobalt present. Using other ordinary ceramic chemicals the glazes had the following mill batches:

0.8	equivalent	of frit (included the color oxide)
0.1	"	of whiting
0.145	"	of Florida clay
0.1	"	of Buckingham feldspar
0.0–1.5	"	of flint in Series I, II, and III
0.6	"	of flint in Series IV to IX.

In all cases where it was possible end or corner members were made and intermediate glazes blended on the basis of dry material in the slip.

The frits were drop fritted into water and ground dry to pass a 150-mesh sieve while the glaze slips were put through a 120-mesh sieve. Application was made on small porous bisque wall tile of which neither the composition nor the firing temperature was known. All glazes were fired in wadded saggers to cone 3 in about 35 hours, and the kiln allowed to cool normally, requiring from two to three days.



The general results of Series I, II, and III are shown in Figs. 1, 2, and 3 in which the shaded areas represent crazing. The colors of all trials in these three series are very muddy-looking browns and far from desirable. Also in all cases where a new trial of any glaze was run in a different firing, the second test piece had a color which varied much from the first. The colors were susceptible to thickness of application and to segregation in minute spots in the glass.

The most desirable composition as determined by Series I, II, and III was

0.152 K_2O	0.35 Al_2O_3	3.00 SiO_2
0.048 Na_2O	0.50 B_2O_3	0.025 NiO
0.350 CaO		
0.450 BaO		

It is interesting to note that, although quite different in RO content, the silica, alumina, and boric oxide contents of this glaze are similar to a glaze (B3) investigated by Montgomery[18] who states that opalescence is quite noticeable giving the glaze a dull, milky appearance. Possibly there is a direct relation between the turbid loam-colored browns obtained in this work and the opalescence obtained in similar colorless glazes reported by Montgomery.

[19] Furnished by the company from which the material was purchased.

The colors of Series I, II, and III glazes indicated that the nickel oxide content was too low, and as a result, the glazes of Series IV were made using the above general formula, and varying the nickel oxide from 0.025 to 0.095 equivalent by increments of 0.010 equivalent. These were fired to cones 3 and 4. Glazes with over 0.075 NiO showed, when viewed carefully in reflected light, a slight surface separation which dulled the surface somewhat. As there was little increase in depth of tone when more than 0.065 NiO was used, this amount was chosen as a constant for the subsequent series.

Series V consisted of 21 glazes which had the following general formula:

$$\left.\begin{matrix} 0.190\ K_2O \\ 0.060\ Na_2O \\ 0.250\ CaO \\ 0.500\ RO\ (\text{variable}) \end{matrix}\right\} \quad \left.\begin{matrix} 0.35\ Al_2O_3 \\ 0.50\ B_2O_3 \end{matrix}\right. \quad \left\{\begin{matrix} 3.00\ SiO_2 \\ 0.065\ NiO \end{matrix}\right.$$

The 0.500 RO group consisted of BaO, MgO, and ZnO varied as shown in Fig. 4. These glazes were fired to cones 2, 3, and 6. Glazes of this series which contained over 0.200 BaO are not to be recommended because of the dirty browns caused by excessive BaO content. Glazes which are high in MgO give a very light green color but have a rough immature surface at cone 6; they offer possibilities, however, if fired slightly higher. Glazes with high ZnO offer good possibilities for art decorations. With 0.300 ZnO or more (BaO must be 0.100 or less) there are formed separations which will vary in color with the firing temperature. Blue separations are secured if the temperature is cone 2 while above cone 3 the separations are of a purplish white tone. In all cases a slightly brownish background is noticeable. No beading tendency was noted with high ZnO content, but a good gloss was obtained.

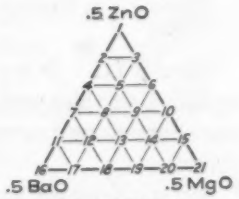


Fig. 4 - Series V

Series VI glazes are shown in Table I. The object was to determine the effect of replacing part of the CaO with MgO while all the other constituents were constant. Trials were fired to cone 3+.

TABLE I

Glaze	General Formula			CaO	MgO
VI-1	0.190 K_2O	0.35 Al_2O_3	3.00 SiO_2	0.55	0.00
VI-2	0.060 Na_2O	0.50 B_2O_3		0.45	0.10
VI-3	0.200 BaO		0.065 NiO	0.35	0.20
VI-4				0.25	0.30

Glaze VI-1 was a pretty semimat glaze with a very light brown color, semi-opaque, and slightly sensitive to thickness of application. Glaze VI-4 was a very rough and immature glaze which showed a dirty green color due to a combination of BaO and MgO. The intermediate glazes

had shades and properties intermediate between the two end glazes. Thus, in replacing MgO for CaO with the above general formula a color change from light brown to a dirty green with increasing immaturity is obtained.

Series VII glazes were the same as Series VI glazes with the exception that the MgO in all cases was replaced by ZnO. These were also fired to cone 3+. Glaze VII-1 is the same as glaze VI-1. Glaze VII-2 is of a brown color which shows slight purplish tints when dipped thickly. Glazes VII-3 and VII-4 are similar to glaze VII-2 except that they show more tendency to purplish tints when thickly applied. They are all non-opaque glazes and are not to be recommended for any use, since their color is undesirable.

Series VIII glazes are shown in Table II. The object was to determine the effect of replacing part of the CaO by BaO while all the other constituents were constant. These were fired to cone 3+.

TABLE II

Glaze	General Formula			CaO	BaO
VIII-1	0.190 K_2O	0.35 Al_2O_3	3.00 SiO_2	0.55	0.00
VIII-2	0.060 Na_2O	0.50 B_2O_3		0.45	0.10
VIII-3	0.200 MgO		0.065 NiO	0.35	0.20
VIII-4				0.25	0.30

Glaze VIII-1 is a pretty greenish tan semi-opaque glaze which is not sensitive to thickness of application. Glazes VIII-2, VIII-3 and VIII-4 show increasing brownish tones. Glazes 1 and 2 would serve as good art glazes.

Series IX glazes were the same as Series VIII with the exception that the BaO in all cases was replaced by ZnO. These, also, were fired to cone 3+. Glaze IX-1 is the same as glaze VIII-1. Glaze IX-2 has a greenish brown color, shows slight devitrification and is semimat. Glaze IX-3 has a decided greenish tinge with slight devitrification. Glaze IX-4 is slightly immature and shows a greenish tinge with white separations. Glaze IX-2 is to be recommended for art purposes while glazes 3 and 4 offer possibilities.

IV. Conclusions and Recommendations

The following statements are all subject to the experimental limits covered in this investigation.

The color of all glossy non-opaque glazes containing nickel oxide is dependent upon thickness of application, firing conditions, and the RO constituents present, as well as their relative amounts. The colors were not easily reproduced in successive firings and cannot be relied upon. In cases where the color was deep (dark) it was usually turbid in character. Lighter colors were not so sensitive to turbidity.

Devitrification tends to cause a fading of the color produced.

Variations of the alumina, silica, or boric oxide content produce no noticeable change in the color.

High BaO will give a brown color which is anything but pretty, is susceptible to segregation of color, and varies considerably in different firings, even in different parts of the same kiln. Three-tenths (0.3) equivalent BaO is sufficient to cause these various defects.

Very high CaO content with either 0.2 MgO or 0.2 BaO gives light tan shades which are not so sensitive to thickness of application. In the case of BaO the shades are darker than with MgO and slightly more sensitive to thickness of application. These glazes are opaque and have a semimat surface.

High MgO offers possibilities of producing light green glazes if the maturing temperature is raised. Not over 0.1 BaO or over 0.2 ZnO (preferably 0.1) should be used. For a cone 3 glaze not over 0.2 MgO can be used as this oxide promotes immaturity.

High ZnO, 0.3 equivalent or over, when used with 0.25 CaO, offers possibilities for art decoration where a glaze is desired which shows a type of devitrification or crystallization. The separations may be blue or purplish white depending upon the amount of ZnO present and the firing temperature. Barium oxide and MgO should be limited to 0.1 equivalent and 0.2 equivalent, respectively.

The results of this work, wherever comparison is justifiable, agree favorably with those of previous investigators.

Summarizing the results shows that, in general:

(1) Nickel oxide has not proved useful in glossy non-opaque glazes.

(2) In any case nickel oxide is not to be recommended for use where a deep (dark) color is desired as all deep colors are of a turbid, loamy nature.

(3) Nickel oxide can be made to produce very pretty opaque glazes, light tan in color, and of a semimat character. The CaO content must be high (0.35 or above, preferably 0.45 or over) while the BaO should be not over 0.2 equivalent and the sum of BaO and MgO not over 0.3 equivalent. When these limits are exceeded the glazes may have undesirable color or poor opacity, which is not satisfactory with nickel oxide as a colorant. These glazes are easily reproducible in firing.

Acknowledgment The writer wishes to thank C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois, for his helpful coöperation and advice in this work and in the preparation of the manuscript.

A STUDY OF THE ABSORPTION OF TWO EARTHENWARE BODIES AND THEIR RESISTANCE TO CRAZING IN THE STEAM TEST[1]

By E. P. Wright

ABSTRACT

An ivory and a white earthenware body fired in different positions of periodic and tunnel kilns and maturing to various absorptions were subjected to autoclave steam treatments at the pressures of 100 and 150 lbs. per sq. inch. The ivory body resisted the crazing induced by this test for absorptions from 7 to 8% in the 100-lb. pressure treatment. The white body withstood the destructive effect up to an absorption of 8.5%. Within a narrow range, thorough glost firing had some effect in increasing the resistance. In the 150-lb. test, the critical resisting absorption was lowered to 6% for each body.

Introduction

It was the purpose of the present work to study the behavior of two earthenware bodies which have been fired under different conditions, when subjected to the so-called steam test. In this test the glazed specimens are placed in an autoclave and submitted to a steam pressure of from 100 to 150 lbs. per sq. inch. Just what this test does we do not know with any degree of exactness. Irrespective of its specific action, whether it causes the fixation of a small amount of chemically combined water, or not, the fact remains that some clays and bodies are influenced by the steam to such an extent that they expand. If now, this expansion is great enough it will result in rupturing the glaze applied to the body. Apparently, other bodies fired under certain conditions do not expand sufficiently to crack or craze the glaze. Without going into the merits of the test it would seem to be safe to say that a body which does not cause its glaze to crack, should on general principles be considered more desirable than one that does. But we should not lose sight of the fact that the steam test cannot determine the relative body and glaze fit with reference to their thermal expansion and hence it is not a true test for crazing. It deals only with a permanent expansion induced by the action of steam upon clay bodies and this fact should be kept strictly in mind.

The Test

The bodies used in this study were the same as those used in the production of white and ivory earthenware dishes.

A sample of each body was taken from the pug mill and thoroughly wedged by hand, in order that all the test pieces would be of the same composition. The test pieces were disks of approximately 70 grams each. A sufficient number of these were made from each body, so that they were

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Illinois, February, 1929. (White Wares Division.) Received December 6, 1928.

placed in eight different positions in the upright bisque kiln and in six different positions in the tunnel bisque kiln, to give the conditions encountered in the manufacture of the ware from the same bodies. The disks were placed as close together as possible in the sagger, and cones used to determine the temperature to which they were fired.

One of the disks of each body from the fourteen positions was used to determine the absorption. Six disks of each body from the bisque kiln positions were dipped in the regular glaze, and fired in the tunnel glost, two disks of the six being used in each of the three positions of the glost fire. These disks were all placed on the same truck in order to get as nearly as possible the same conditions for each set of samples.

After the glost fire the disks were divided into two groups, where each body was represented by the fourteen positions of the bisque fire and each of these positions represented by the three positions of the glost fire.

One set of disks was tested in the autoclave at a steam pressure of 100 pounds for 3 hours, and the second set at a pressure of 150 pounds for 2 hours. The condition of each disk with reference to the state of the glaze, whether crazed or not crazed, was then carefully noted. The results of the examinations are compiled in Tables I, II, III, and IV.

TABLE I

IVORY BODY IN UPRIGHT BISQUE KILN

Position in bisque kiln	Bisque cone	Absorption (%)	Position in glost kiln	Glost cone	100 lbs. steam 3 hrs.	Cone	150 lbs. steam 2 hrs.
1	9	4.51	A	2−	O.K.	2−	O.K.
1	9	4.51	B	4	"	4	"
1	9	4.51	C	3+	"	3+	"
2	9+	4.04	A	2−	"	2−	"
2	9+	4.04	B	4	"	4	"
2	9+	4.04	C	3+	"	3+	"
3	8+	5.88	A	2−	"	2−	"
3	8+	5.88	B	4	"	4	"
3	8+	5.88	C	4−	"	4−	"
4	9	4.62	A	2−	"	2−	"
4	9	4.62	B	4	"	4	"
4	9	4.62	C	3+	"	3+	"
5	8−	8.03	A	2−	O.K. (thin glaze)	2	Badly crazed
5	8−	8.03	B	4	Slightly crazed	4	Slightly crazed
5	8−	8.03	C	3+	Slightly crazed	3+	Slightly crazed
6	8	7.21	A	2−	Slightly crazed	2	Badly crazed
6	8	7.21	B	4	O.K.	4	Slightly crazed
6	8	7.21	C	3+	Slightly crazed	3	Crazed
7	7−	9.33	A	2−	Badly crazed	2−	Badly crazed
7	7−	9.33	B	4	Slightly crazed	4	Badly crazed
7	7−	9.33	C	3+	Badly crazed	4−	Badly crazed
8	8−	7.84	A	2−	Slightly crazed	2−	Badly crazed
8	8−	7.84	B	4	Slightly crazed	4	Badly crazed
8	8−	7.84	C	3+	Slightly crazed	3+	Badly crazed

TABLE II

IVORY BODY IN TUNNEL BISQUE KILN

Position in bisque kiln	Bisque cone	Absorption (%)	Position in glost kiln	Glost cone	100 lbs. steam 3 hrs.	Cone	150 lbs. steam 2 hrs.
9	9+	6.36	A	2−	O.K.	2	Slightly crazed
9	9+	6.36	B	4	"	4	Slightly crazed
9	9+	6.36	C	3+	"	3+	Crazed
10	9	8.52	A	2−	Badly crazed	2	Badly crazed
10	9	8.52	B	4	Slightly crazed	4	Crazed
10	9	8.52	C	3+	Badly crazed	3+	Badly crazed
11	9	7.08	A	2	Badly crazed	2	Badly crazed
11	9	7.08	B	4	Slightly crazed	4	Crazed
11	9	7.08	C	3+	Slightly crazed	3+	Badly crazed
12	9+	6.03	A	2	O.K.	2	O.K.
12	9+	6.03	B	4	"	4	"
12	9+	6.03	C	3+	"	3+	Crazed
13	10	5.18	A	2	"	2	O.K.
13	10	5.18	B	4	"	4	"
13	10	5.18	C	3+	"	3+	"
14	10	4.84	A	2	"	2	Slightly crazed
14	10	4.84	B	4	"	3+	O.K.
14	10	4.84	C	3+	"	3+	"

TABLE III

WHITE BODY IN UPRIGHT BISQUE KILN

Position in bisque kiln	Bisque cone	Absorption (%)	Position in glost kiln	Glost cone	100 lbs. steam 3 hrs.	Cone	150 lbs. steam 2 hrs.
1	9	7.08	A	2−	O.K.	2−	Slightly crazed
1	9	7.08	B	4	"	3+	Slightly crazed
1	9	7.08	C	4−	"	4−	Slightly crazed
2	9+	6.19	A	3	Slightly crazed	3	Slightly crazed
2	9+	6.19	B	3+	O.K.	3+	O.K.
2	9+	6.19	C	4−	"	4−	"
3	8+	8.51	A	3	O.K.	3	Crazed
3	8+	8.51	B	3+	"	3+	Slightly crazed
3	8+	8.51	C	4−	"	4−	O.K.
4	9	7.10	A	2−	"	3	Slightly crazed
4	9	7.10	B	4	"	4	O.K.
4	9	7.10	C	4−	Slightly crazed	4−	Slightly crazed
5	8−	10.83	A	3	Badly crazed	3	Badly crazed
5	8−	10.83	B	4	Slightly crazed	4	Badly crazed
5	8−	10.83	C	4−	Badly crazed	4−	Badly crazed
6	8	9.56	A	3	Badly crazed	3	Badly crazed
6	8	9.56	B	4	Slightly crazed	4	Badly crazed
6	8	9.56	C	4−	Badly crazed	4−	Badly crazed
7	7−	11.85	A	3	Badly crazed	3	Badly crazed
7	7−	11.85	B	3+	Badly crazed	3+	Badly crazed
7	7−	11.85	C	4−	Badly crazed	4−	Badly crazed
8	8−	10.16	A	3	Badly crazed	3	Badly crazed
8	8−	10.16	B	4	Badly crazed	4	Badly crazed
8	8−	10.16	C	4−	Badly crazed	4−	Badly crazed

TABLE IV

WHITE BODY IN TUNNEL BISQUE KILN

Position in bisque kiln	Bisque cone	Absorption (%)	Position in glost kiln	Glost cone	100 lbs. steam 3 hrs.	Cone	150 lbs. steam 2 hrs.
9	9+	8.76	A	2−	Slightly crazed	3	Crazed
9	9+	8.76	B	3+	Slightly crazed	3+	Slightly crazed
9	9+	8.76	C	4−	Slightly crazed	4−	Crazed
10	9	10.56	A	2−	Badly crazed	3	Badly crazed
10	9	10.56	B	3+	Badly crazed	3+	Badly crazed
10	9	10.56	C	4−	Badly crazed	4−	Badly crazed
11	9	10.02	A	2−	Badly crazed	3	Badly crazed
11	9	10.02	B	3+	Badly crazed	3+	Badly crazed
11	9	10.02	C	4−	Badly crazed	4−	Badly crazed
12	9+	8.66	A	2−	Slightly crazed	2	Crazed
12	9+	8.66	B	3+	Slightly crazed	3+	Slightly crazed
12	9+	8.66	C	4−	Badly crazed	4−	Crazed
13	10	7.07	A	2−	Slightly crazed	3	Slightly crazed
13	10	7.07	B	4	Slightly crazed	3+	Slightly crazed
13	10	7.07	C	4−	O.K.	4−	Slightly crazed
14	10	7.60	A	2−	"	2−	Slightly crazed
14	10	7.60	B	4	"	3+	Slightly crazed
14	10	7.60	C	4−	"	4−	Slightly crazed

Discussion of Results

The results show that the ivory body with an absorption below 7% withstood the steam test at 100 lbs. pressure for three hours, irrespective of the kind of glost firing. But with an absorption between 7 and 8% the resistance to the steam action was improved by more thorough glost firing. For absorptions above 8% failure in the steam test occurred no matter what the glost firing might have been.

With a steam pressure of 150 lbs. maintained for two hours, the critical absorption with reference to the resistance in the autoclave test dropped by 1%. This means that to withstand these conditions the ware must have an absorption of 6%, or lower. Between the absorption of 6 and 7% the kind of glost firing was able to affect the resistance, but with absorptions of above 7% failure took place no matter how favorable the glost firing conditions were.

The white body showed a higher absorption than the ivory body at the same firing temperature and when subjected to a steam pressure of 100 lbs. for 3 hours it showed very little crazing when the absorption was below 8.5%. The kind of glost firing seemed to have no general effect on the resistance when the absorption was above 8.5%.

With a steam pressure of 150 lbs. maintained for two hours, the destructive action was not resisted until the absorption had dropped to 6%. The kind of glost firing treatment exerted some influence with absorption ranging between 6 and 8.5% but was ineffective for absorption above the higher limit.

From these results it appears that the bisque firing treatment as expressed by the absorption is of primary importance in regard to the resistance to crazing in the steam test, the lower the absorption the greater the resistance. In the case of each type of body there is a narrow range within which favorable glost firing conditions tend to improve the resistance.

It seems then that the steam treatment at 100 lbs. pressure will cause crazing above an absorption of 7 to 8% for the ivory body and above 8.5% for the white body. The treatment at 150 lbs. pressure was more severe and lowered the critical resisting absorption to 6% in each case.

Acknowledgment The writer is indebted to A. V. Bleininger for suggesting the subject of this paper.

THE HOMER LAUGHLIN CHINA COMPANY
NEWELL, W. VA.

THE SERVICE OF REFRACTORY BLOCKS IN A SMALL EXPERIMENTAL GLASS TANK[1]

By W. L. Pendergast and Herbert Insley

ABSTRACT

Tests to determine the relative resistance of various types of refractories to the action of flowing molten glass were made in a small laboratory glass-melting furnace similar in shape and in operation to commercial scale, continuous glass tanks. The results of tests made in nine runs of the furnace, each run continuing for approximately 30 days, are given. The resistance of the refractories to glass attack apparently does not depend entirely upon chemical composition and porosity of the refractories, but is probably related also to (1) the size of pores, (2) the relative composition of grog and bond, and (3) the degree of adherence between particles in the refractory.

Introduction

During the past few years there has been a marked tendency in the glass industry to increase the temperature for melting. This, naturally, has resulted in a more rapid disintegration of the refractory blocks. Moreover, refractory blocks from different manufacturers have shown widely different resistance to glass attack and even blocks from the same manufacturer made apparently of the same materials and with the same processes have at times varied greatly in service.

While some theories have been advanced to account for the difference in resistance of different blocks, apparently little experimental work has been done to evaluate and correlate the factors that determine the degree of resistance of tank block to glass attack. The Bureau of Standards in 1924, therefore, inaugurated a laboratory investigation on commercial tank block. For this purpose experimental gas-fired, continuous glass tanks were constructed so that the tank blocks in the sides could be easily replaced. Nine melts were made between September, 1924, and October, 1927, using refractories prepared in the laboratory as well as blocks furnished by various manufacturers. Glass was melted in each of the nine tanks, a test run continuing for approximately 30 days.

Description of Furnace

In its final form the furnace was a modified downdraft kiln, the gases burning while they passed horizontally over the tank. The furnace operated quite satisfactorily, considering that the fuel used was a carbureted water gas supplied for domestic use, averaging about 600 B.t.u. per cubic foot. Two burners with $^1/_2$-inch orifices were sufficient to maintain the required temperature. The tank itself was 12 inches high, 12 inches wide, and 4 feet long, the glass level being maintained about 2 inches from the

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce. Received January 2, 1929.

top of the tank, *B*. Batch was fed in at *F* (Fig. 1), the molten glass passed through the opening in the bridge wall and was drawn off at *D*. The crown was of silica brick with the exception of the Carborundum block which contained the batch feeding hole (*F* in Fig. 1). The bottom blocks and tuck stones were made of a modified glass-pot body developed at the Bureau of Standards and composed of 50% firebrick grog fired to cone 16 and 50% of unfired material. The unfired materials were composed largely of Tennessee and Kentucky ball clays and North Carolina kaolin with minor amounts of Georgia and Delaware kaolins and feldspar.

Method of Testing

Batch fills at $12^1/_2$ pounds each were made every 15 minutes during eight consecutive hours. Results showed that the rate of glass movement under

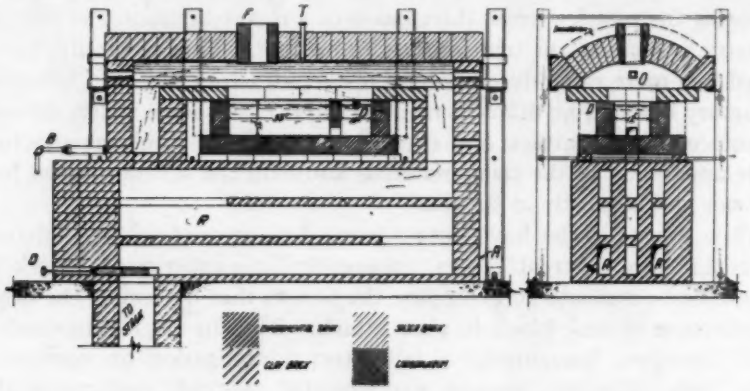


FIG. 1.

these conditions was sufficient to give marked corrosion with most refractory blocks at the end of 30 days' melting time.

Composition of Batch

The batch used was composed of 1000 pounds of sand, 700 pounds of soda ash, 200 pounds of limestone, and 2 pounds of sodium nitrate. One part of cullet was mixed with three parts of batch.

The calculated chemical composition of the batch, based upon the proportions used and chemical analyses made of the soda ash and limestone, is SiO_2 66.3%, Na_2O 26.8, CaO 4.0, and MgO 2.9. This batch is considerably higher in soda than the average soda-lime bottle glass batch and therefore more corrosive.

Temperature Measurements

The temperatures during the melting period were read with an optical pyrometer which was sighted on the center of the arch. In one run four platinum, platinum-rhodium thermocouples were inserted through small holes in

the side-wall blocks. Three of the couples were inserted midway of the length of the furnace, one at the surface of the glass, one near the bottom of the tank, and one half-way between. The fourth couple was ten inches nearer the end wall of the melting chamber than the other three and at the bottom of the tank. A difference of about 50° between couples at the bot-

FIG. 2.

tom and top of the glass in the same vertical line was observed. The couple at the surface of the glass gave a temperature 50° lower than the optical when the optical read 1550° and about 40° lower when the optical read 1530°.

FIG. 3.

Description of Tests

Tank 1 The side walls of the first tank were built of six blocks furnished by three manufacturers. The blocks marked 1A (Fig. 3) and 1B (Fig. 2) were from the same manufacturer and were alike in composition and treatment except that 1B was refired to cone 15 at the Bureau of Standards. All the blocks were 6 inches thick.

Since this was a first run, various unforeseen troubles arose which necessitated shutting down the furnace three times. Consequently, the time during which batch was melted was only 13 days. The average tempera-

ture during the melting period was 1420° and 3800 pounds of batch were melted. The severity of service in this tank was considerably less than in any other tank in the series. Nevertheless, the blocks showed fairly severe corrosion. Figures 2 and 3 are photographs of the side-wall blocks arranged after dismantling the tank in the relative positions which they

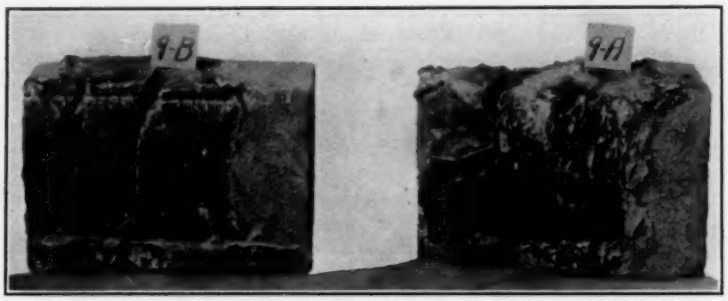


FIG. 4.

occupied during the run. The bridge wall is toward the left in Fig. 2 and toward the right in Fig. 3. The end-wall blocks are shown in Fig. 4, the melting chamber end wall on the right and the refining chamber end wall on the left. All of the blocks showed serious spalling at the upper

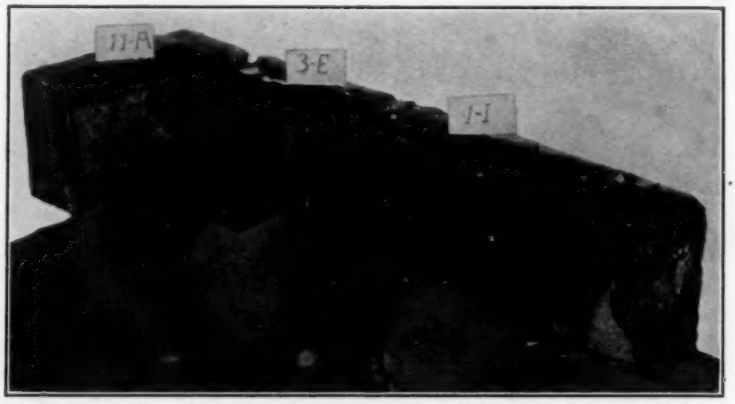


FIG. 5.

inside edges, probably because the furnace was shut down several times during the first three days of the test.

Tank 2 The side walls of Tank 2 were built of six commercial blocks, all six inches thick, furnished by three manufacturers. Block 1I is the same as 1L, except that the former was refired to cone 15

(Figs. 5 and 6). Batch was melted in this tank for 34 days at an average temperature of about 1450°C. Nine thousand pounds of batch were used. Although this average temperature was slightly higher

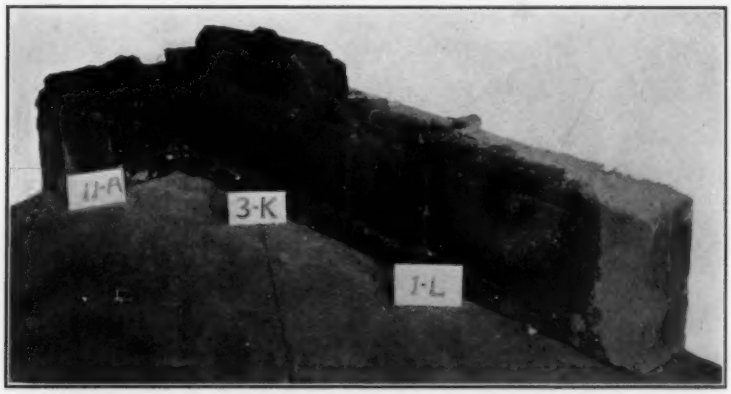


FIG. 6.

(25°) than that of Tank 9, the melting period was 10% shorter and the amount of batch used 25% less (Table I). As affecting the amount of corrosion on tank walls, therefore, service conditions in Tank 2 were prob-

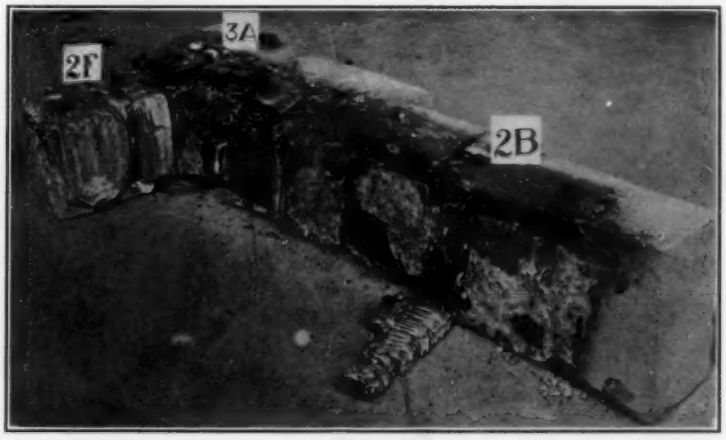


FIG. 7.

ably slightly less severe than in Tank 9. Figure 5 is a photograph of one side wall, a portion of the bridge and the refining end wall, and Fig. 6 shows the other side wall and the melting-end wall. The bridge-wall

block, which was a commercial refractory, was partially destroyed, but all the side-wall blocks were quite free from pits and corrugations and showed little evidence of corrosion except at the glass line. Even at the

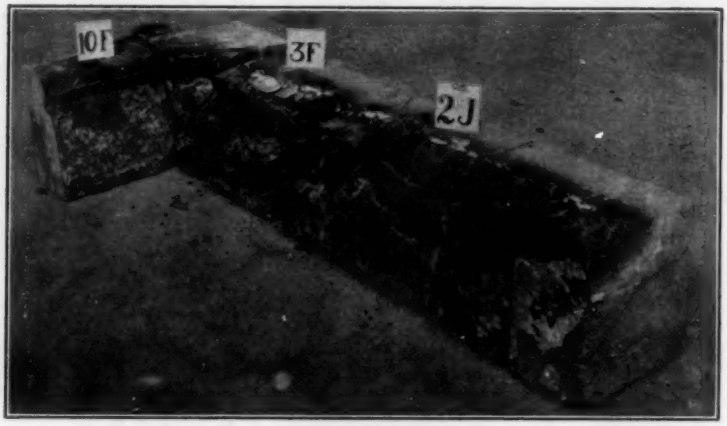


FIG. 8.

glass line the depth of corrosion was not great as compared with that in most of the other tanks in the series. The commercial block refired to cone 15 showed 9.2% absorption as compared with 13% absorption for

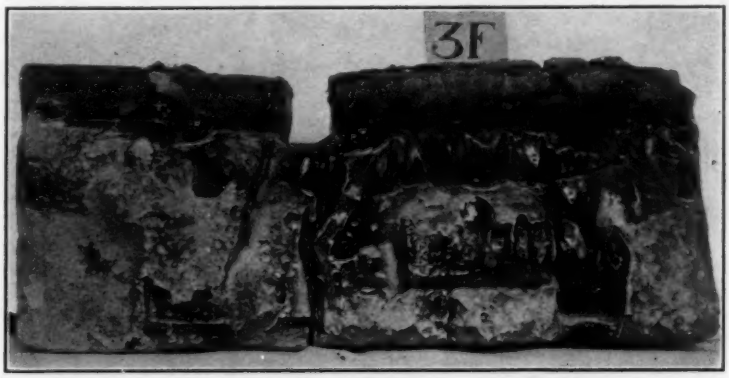


FIG. 9.

the block of the same manufacture not refired. The refired block also showed a slightly greater resistance to glass attack.

Tank 3 The six blocks making up the side walls of Tank 3 were from three manufacturers and the bridge wall also was a piece of a commercial block. During a melting period of 26 days the tank

was operated at an average temperature of 1525°C and approximately 9000 pounds of batch were used. Although the average operating temperature was about as high as for any tank in the series, the melting period was unusually short. Consequently, the severity of service was less than for Tanks 4, 5, and 6 and may be considered as about equal to Tank 7. Figure 7, a photograph of one side wall, the melting-chamber

FIG. 10.

end wall, and a detached piece of the bridge, shows the marked effects of glass attack on the end wall and the blocks in the melting end of the tank. Figure 8 is a photograph of the other side of the tank with the refining-chamber end wall. The bridge was eaten through and broken away from the side walls and the indentation at the glass line was greater than two inches on all the blocks in the melting end of the tank and reached a maximum of $3^3/_4$ inches on block 2J (Fig. 8). Block 2J showed more attack than any other block in the tank. This was in large part due to the presence of vertical and horizontal cracks or laminations which provided starting places.

FIG. 11.

Corrosion upward from horizontal cracks, so characteristic of the action in many commercial tanks, is well exemplified in Blocks 3F (Fig. 9), 3A (Fig. 7), and 2F (Fig. 7). Block 2F was also worn back greatly above the glass line. It should be noted that this block contained more silica (73%) than any other wall block used in this series of experiments.

One sample of each of the following materials was dropped into the melting chamber of Tank 3 and left there until the end of the run.

(A) Fused quartz disk (13 ozs.)
(B) Cylinder of calcined alumina and kaolin (approximately 50% SiO_2, 50% Al_2O_3) fired to 1400° in three hours (20 ozs.)
(C) Fireclay brick (38 ozs.)
(D) Sandstone block (70 ozs.)
(E) Fused alumina block (46 ozs.)
(F) High alumina (80–85% Al_2O_3) block (55 ozs.)

All the specimens had dissolved or disintegrated except the fused alumina block which was reduced to about one-half the original size and the high alumina block which was reduced to one-quarter the original size.

Tank 4 Tank 4 was built of commercial blocks, all 8 inches thick. It was run for a melting period of 36 days at an average temperature of 1525°C and 13,000 pounds of batch were used. This tank undoubtedly had the severest service of any in the series. All the blocks were greatly worn both at and below the glass line. Figure 10 shows one side wall and a part of the refining end wall; Fig. 11 the other side wall and a part of the melting end wall. In the melting chamber the average depth of erosion at the glass line was five inches and below the glass line more than one inch. In Blocks Y and 2D irregular vertical channels and horizontal benches were formed which began at cracks. Although blocks marked 2B were very badly worn, they showed no evidence of cracks or laminations. The difference in depth of corrosion on these blocks and the adjoining ones is well shown in Fig. 12. The bridge wall, although 11 inches thick, was almost entirely eaten away below the glass line (Fig. 13).

FIG. 12.

Tank 5 Tank 5 was built of six commercial blocks and three special blocks. Of the latter, one (GP) was made of a glass pot body using firebrick grog and the other two (marked BS30) were made from batch, furnished by a block manufacturer, which was made up and fired to cone 15 at the Bureau of Standards. The tank was operated during a period of 35 days at an average temperature of 1525° and 11,000 pounds of batch were melted. The conditions in this tank were only slightly less severe than in Tank 4.

The blocks in the melting chamber (on the right in Fig. 14 and on the left in Fig. 15) showed marked effects of glass action. Block 8A is unusual in that it shows numerous, repeated, vertical flutings or corrugations. The deeper channels due to pronounced vertical cracks or laminations can also be observed. Block GP was worn to a depth of 5 inches at the glass

line. Below the glass line the surface in contact with the glass was honeycombed with pits (Figs. 15 and 16). In places these pits extended to within two inches of the cool surface. The pitting may be ascribed to a combination of rather high porosity and to easy solubility in the glass. Although the blocks contain only about 56% of silica, the percentage of fluxes present is rather high, about 3%. One of the blocks made at the Bureau of Standards from a manufacturer's batch was used in the melting chamber (BS30 in Fig. 15). It withstood corrosion very well, but its position next to the bridge wall was particularly favorable.

Tank 6 The walls and bridge of Tank 6 were built of five commercial and five experimental blocks. All the blocks were six inches thick except the bridge block, which was 10 inches. The tank was operated for 36 days at an average temperature of 1500°C and 12,000

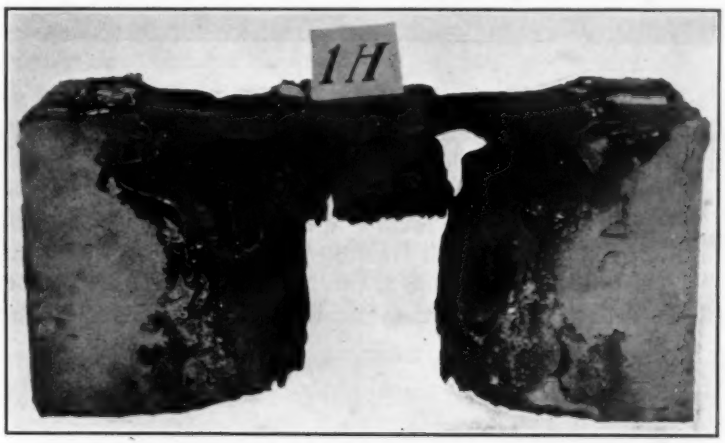


FIG. 13.

pounds of batch were melted. While the average temperature was 25° lower than in Tank 5, the amount of batch used was slightly greater. Of particular interest were the tests on the experimental blocks. The blocks marked RAC (Fig. 17) were composed of artificial corundum (made by electric furnace fusion) of 14-mesh or finer. The alumina grains were bonded with 10% clay and fired. As Fig. 17 shows, these blocks were badly honeycombed and eaten away. The depth of indentation at the glass line was about three inches. The blocks marked RSC (Fig. 18) were composed of crystalline mullite (made by electric furnace fusion) of 14-mesh or finer. The mullite grains were bonded with kaolin and alumina in the proportions to give mullite, and fired. The mullite blocks were also badly corroded and honeycombed although the pits were much smaller than in the alumina blocks (Fig. 19).

An experimental block three inches thick composed largely of spinel ($MgO \cdot Al_2O_3$) was placed in the tank as a part of the bridge wall. It formed the portion of the bridge wall in the melting chamber and was backed by a clay block seven inches thick. The only remaining fragment of this block is marked MA (Fig. 18). It seems probable from this evidence that spinel is readily attacked by molten soda-lime glass. Although the clay

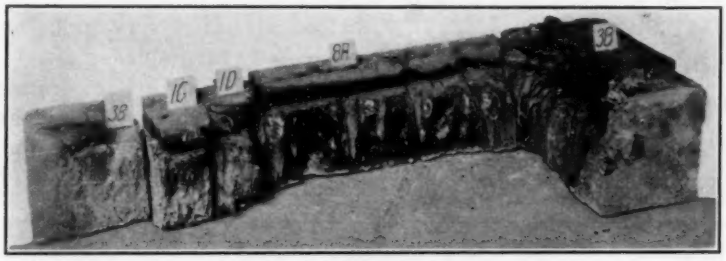


FIG. 14.

portion of the bridge (3C, Fig. 18) was eaten through, it withstood glass attack far better than the spinel.

Tank 7 The walls of the melting chamber of Tank 7 were built of two alumina blocks, two mullite blocks, and one block (forming the end wall) of a commercial batch fired to cone 15 at the Bureau of Standards. The bridge wall was made of two blocks, back to back, a Georgia kaolin block fired to cone 15 at the Bureau of Standards facing the melting

FIG. 15.

chamber and a block of commercial batch fired to cone 15 at the Bureau facing the refining chamber. The side walls of the refining chamber were two commercial blocks of the same brand and the end block was of Georgia kaolin fired at the Bureau of Standards.

The tank was operated for 37 days at an average temperature of 1450°C, and 12,000 pounds of batch were melted. Due to the lower temperature, service conditions were somewhat less severe than in Tank 6.

The blocks marked RAF (Fig. 20) were of the same composition (90% artificial corundum, 10% clay) as the blocks RAC in Tank 6, but the alumina was much finer grained. Of this pair the block on the right was originally six inches thick from the bottom to a horizontal line about four inches from the top. Above the line the inside face was beveled off so that the glass surface made an oblique angle with the face of the block. The block on the left was four inches thick below the horizontal line shown in the photograph and six inches above. The latter block was made in this way to furnish a ready-made horizontal downward facing surface where the characteristic "upward eating" could take place if the block were susceptible to it. Figure 20 shows some evidence of this action. The fine-grained alumina blocks offered much greater resistance to glass action than did the coarse-grained blocks (Figs. 17 and 19). The alumina blocks in Tank 7 were eaten back about one inch at the glass line. No pitting was visible on the surface exposed to glass action.

FIG. 16.

The mullite blocks (RSF in Fig. 21) were the same as the mullite blocks in Tank 6 except for increased fineness of grain. Here again the finer-grained blocks showed a marked improvement in resistance to glass action. The left-hand block in Fig. 21 was corroded to a depth of one inch at the

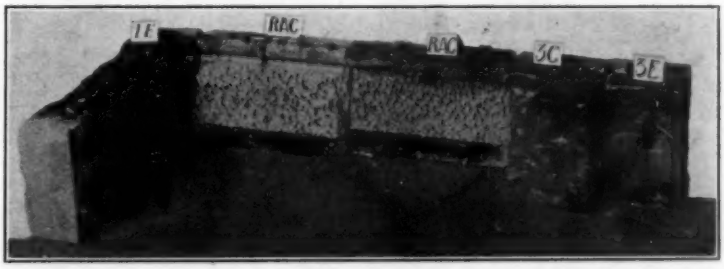


FIG. 17.

glass line, the right-hand block to a depth of two inches. In general, there was little wearing away below the glass line although in the left-hand block there are two cracks along which marked corrosion has taken place. These cracks may have formed during the heating period in the tank before glass melting began. The Georgia kaolin blocks forming the end wall in the refining chamber and a part of the bridge wall are seen in Fig. 21 (GA1 and GA2). The end wall was corroded at the glass line to a depth of $2^1/_2$

inches and was very badly pitted below the glass line. The portion of the bridge wall composed of the kaolin brick was eaten through from bottom to top and was also badly pitted. Needless to say, such a test does not give a fair idea of the solubility of fired kaolin in molten glass. The struc-

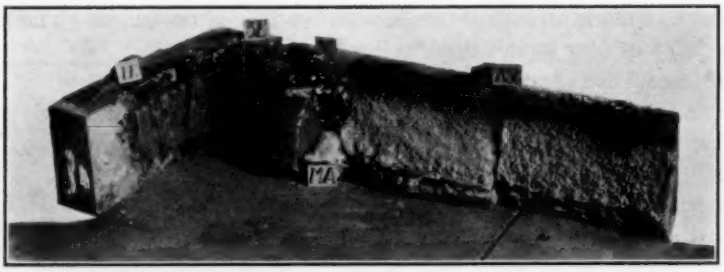


FIG. 18.

ture was necessarily very open and apparently disintegration of the block was caused primarily by entrance of molten glass into the pores.

Tank 8 All of the blocks in the melting chamber of Tank 8 were experimental with the exception of the end wall. The tank was operated for 27 days at an average temperature of 1450°C and approximately 11,000 pounds of batch were melted. Although the average melting

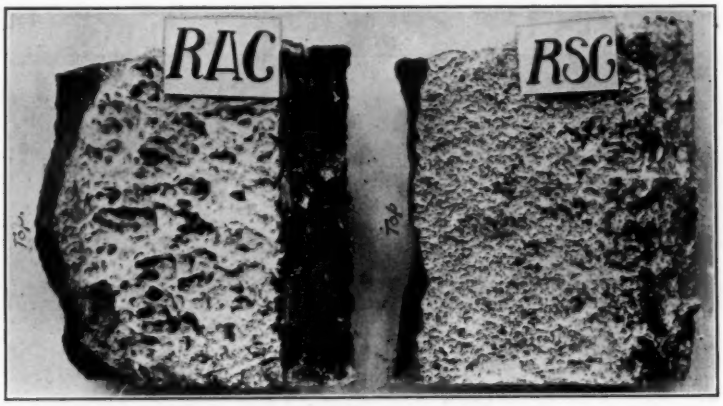


FIG. 19.

temperature was 25° higher in Tank 8 than in Tank 9, the duration of run and the amount of batch melted were considerably less than in the latter and the severity of service can be considered approximately the same in the two tanks.

The blocks in the side walls of the melting chamber (Figs. 22 and 23) resisted glass action unusually well, probably in part because the operating conditions were not as severe as in some of the runs. The commercial block in the end wall of the melting chamber (H_2), however, showed as

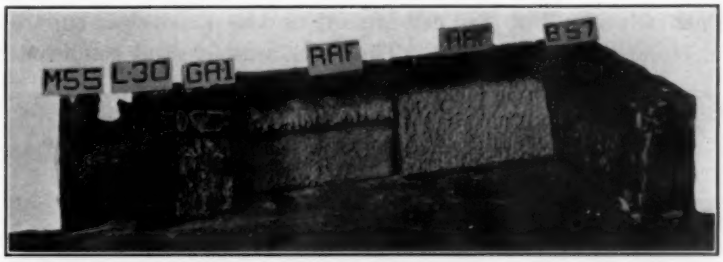


FIG. 20.

much wear as end blocks in runs where operating conditions were more severe.

Blocks M2 (Fig. 22) and M1 (Fig. 23) were dry-pressed blocks made wholly of Missouri flint clay. The grog, composing 45% of the block, was fired to cone 14 at a plant manufacturing tank block, shipped to the Bureau where the raw clay was added, dry pressed at 1500 pounds per square inch, and fired to cone 16. These blocks were worn $1^1/_2$ inches at the glass line and were in comparatively good condition at the end of the run. Block

FIG. 21.

M3 (Fig. 22) was a hand-made diaspore block, finished with hand tamping and fired to cone 16. It was worn to a depth of $1^1/_2$ inches at the glass line and apparently was similar to M2 in resistance to glass action. Block A1–2 (Fig. 22) was an experimental hand-rammed block made of calcined cyanite. Although it showed fair resistance to glass action and was worn only $1^1/_2$ inches at the glass line, it was badly pitted and contained one long curved crack along which marked corrosion took place. Block 35

(Fig. 23) was made of the same material as Block A1–2, but was dry-pressed to 3500 pounds per square inch instead of hand-rammed. As the photograph indicates, this block withstood glass action much better than A1–2, the pits were few and small and there were no cracks. Block K was made of the glass-pot batch used in the bottom blocks and tuck stones in all the experimental tanks, but was dry-pressed to 850 pounds per square inch instead of being hand-rammed. The block was in good condition after

FIG. 22.

the run, except for a large crevice probably formed during the firing of the block or the heating up of the tank.

Tank 9 All the blocks in the walls of Tank 9 are of the so-called "special refractory" type, with the exception of the bridge, which was built of a commercial clay tank block and Block D, which is a commercial clay block fabricated by an unusual process.

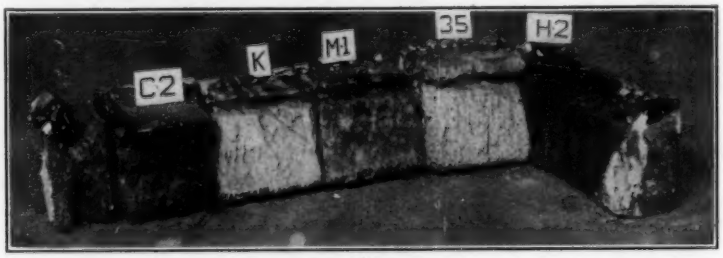


FIG. 23.

This tank was operated at an average temperature of 1425° for 38 days during which time 12,000 pounds of batch were melted. While conditions in this tank were less severe than in Tanks 4, 5, 6, and 7, they were probably approximately the same as in Tanks 2 and 8 (Table I). Tank 2 was operated at an average temperature 25° higher than Tank 9, but considerably less batch was melted. In Tank 8 the average temperature was also 25° higher than in Tank 9, but the duration of the run was much shorter.

The effect on the wall blocks is seen in Figs. 24, 25, and 26. Block A, the bridge wall, is a commercial clay block. It shows severe corrosion, but considering that the bridge wall in many runs was almost wholly eaten away, it resisted glass action remarkably well.

Block C (Figs. 24 and 26) was a special refractory. Petrographic examination showed that it was composed largely of very minute crystals of mullite in glass with a little granular corundum. Apparently, a large part

FIG. 24.

of the mullite and glass had been formed by the dissociation of cyanite, since large aggregates of minute needles of mullite and glass contained remnants of undissolved cyanite grains at their centers. This block was badly pitted after service and showed the least resistance to corrosion of any block in the tank. Disintegration probably resulted more from porous structure or from lack of homogeneity than from chemical composition. Blocks E and F (Figs. 24 and 26) were from the same manufacturer and

FIG. 25.

were made, it is understood, of an electrically fused mixture containing alumina and silica in the proper proportions to form mullite.

After use in the furnace the blocks were broken in half and specimens chipped from several places on the fractured faces. Petrographic examinations of these chips gave the following results. Block E was found to be composed of mullite ($3Al_2O_3 \cdot 2SiO_2$), corundum (Al_2O_3), glass, and opaque material. In all the chips examined mullite was the most abundant constituent although the relative amount present varied from place to place

in the block. Corundum varied from 10 to 30%. Glass in small amounts was observed in channels between the mullite crystals. The opaque material occurred as lenticular masses and dendritic growths included in both mullite and glass. Chips from Block F were composed largely of corundum, with small amounts of glass, mullite, and an unidentified compound with very high index of refraction and high double refraction. Corundum occurred in large, well-formed crystals and was evidently the first compound to crystallize. The mullite crystals, although very small, were well developed and were enclosed in glass. In all probability crystallization of the mullite took place after the corundum.

These two blocks showed greater resistance to glass attack than any of the other blocks in this series of tests. The indentation at the glass line

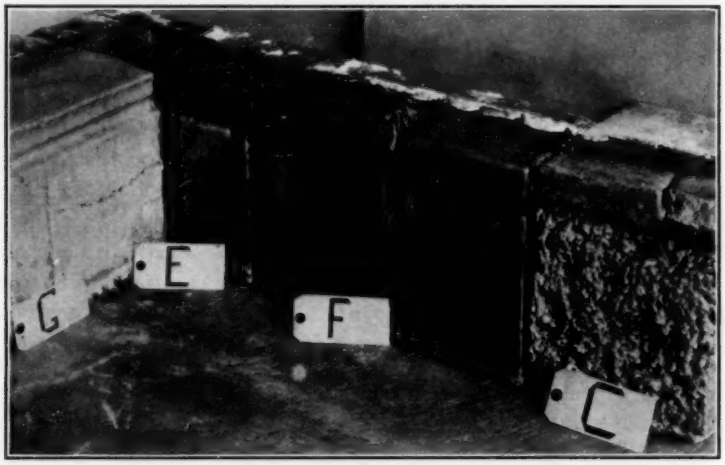


FIG. 26.

was only $^1/_2$ to $^5/_8$ inch with a maximum corrosion at the center of the block of about $^1/_4$ inch. Block E cracked some time after installation. The surface also showed some checking. Block F was partially cracked when received and the cracks continued through the block during tests. Glass attack at the cracks in these blocks was not appreciably more than at any other part of the surface of the block below the glass line (Fig. 26).

Block G used as the end wall of the melting chamber was a special refractory. Petrographic examination showed that it was composed of fairly coarse grains of corundum and mullite with interstitial glass. The interstitial glass often contains well-developed needles of mullite. The structure suggests that the block is composed of mullite and corundum formed by electrical fusion, afterward bonded with an aluminum silicate (perhaps clay) and fired to a rather high temperature. Although the block

was in a position in the furnace where corrosive action of the melt was pronounced, it showed excellent resistance to such action. There was an indentation at the glass line of about an inch while the center of the exposed face was corroded only about one-half inch. Four cracks developed in the same block some time after installation, but glass attack along these cracks was not excessive.

Block B was a special refractory composed, according to petrographic examination, of corundum, andalusite, and quartz in fairly coarse grains, corundum and andalusite being the most abundant constituents. The edges of the andalusite grains were converted to a mixture of mullite and glass. This block also withstood glass attack exceptionally well. A few very small pits were found in the face of the block and the indentation at the glass line was only about an inch.

Block D is a clay block which, it is understood, received a somewhat unusual treatment before firing. This block compared favorably with the best clay blocks previously tested. The block was eaten away at the glass line to a depth of $1^1/_4$ inches. A few small pits developed in the face and one fairly large oblique crack which was further enlarged by glass attack.

Discussion of Results

Any attempt to make direct comparisons between blocks used in different tanks or even in the same tank is not justified. A review of the photographs of the blocks after use shows at once that blocks in different positions in the same tank were not exposed to the same corrosive action. In general, the bridge wall received the most severe treatment. Blocks in the melting chamber were exposed to much more severe conditions than those in the refining chamber and of the former the end-wall position was the worst. Next in order are the side-wall blocks nearest the end wall and then the side-wall blocks nearest the bridge.

TABLE I

Tank No.	Duration of test (days)	Average temperature in arch (°C)	Batch melted (pounds)
2	34	1450	9,000
3	26	1525	9,000
4	36	1525	13,000
5	35	1525	11,000
6	36	1500	12,000
7	37	1450	12,000
8	27	1450	11,000
9	38	1425	12,000

Table I is useful in estimating the relative severity of conditions in the different tanks. It is evident that conditions were not the same in all the tanks and that consequently a block from one tank can not always be com-

pared with a block from any other tank even though the blocks occupied the same positions.

The table shows, however, that Tanks 5 and 6 are comparable in operating conditions as are Tanks 2, 8, and 9.

Tank 4 had the most severe treatment.

Chemical analyses and absorption determinations were made on most of the blocks used (Table II), but in general there appears to be little rela-

TABLE II

Tank No.	Block No.	Chemical Composition (per cent)						Absorption (per cent)		
		Ignition loss	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	Sum	Total	After[1] five minutes	Softening point (cones)
	9A	0.37	59.60	35.46	1.72	2.01	99.16	11.6	60.2	30
	1B	0.18	70.36	25.40	1.82	1.56	99.32	12.6	53.4	28
	10B	0.20	61.34	34.05	1.69	2.08	99.36	10.9	54.6	29–30
	10A	0.20	61.34	34.05	1.69	2.08	99.36	10.9	54.6	29–30
	1A[2]							11.5	55.8	29–30
1	9B[3]							11.6	60.2	30
	BS[4]									
	Block[4] (bridge)									
	11A	0.30	62.30	33.01	1.49	2.06	99.16	14.4	75.7	30
	1L	0.34	57.66	37.37	1.85	1.92	99.14	9.2	54.5	32
2	3K	0.30	63.50	31.37	1.91	1.88	98.96	11.4	65.4	28
	3E	0.14	64.24	31.02	1.92	1.88	99.20	14.1	76.0	27
	1I	0.32	57.38	37.35	1.79	1.90	98.74	13.0	70.9	32
	Bridge[4]									
	2F	0.30	73.16	23.17	1.03	1.56	99.22	11.5	67.0	27
	2J	1.48	70.60	24.18	1.48	1.60	99.34	12.8	52.1	27
3	3A	0.14	64.24	31.02	1.92	1.88	99.20	14.6	66.6	27
	3F	0.30	63.50	31.37	1.91	1.88	98.96	12.6	68.7	28
	2B	0.34	65.06	29.67	2.05	1.80	98.92	15.5	67.5	29
	10F[5]									
	30A	0.34	57.66	37.37	1.85	1.92	99.14	14.2	67.4	32
	2B	0.34	65.06	29.67	2.05	1.80	98.92	11.2	69.2	29
	y	0.18	70.36	25.40	1.82	1.56	99.32	11.5	55.8	28
4	2D	0.36	56.44	37.88	1.80	1.96	98.44	12.6	53.5	32
	2B	0.34	65.06	29.67	2.05	1.80	98.92	15.5	67.5	29
	2F	0.30	73.16	23.17	1.03	1.56	99.22	11.5	70.0	27
	5B[4]									
	1H	0.14	64.24	31.02	1.92	1.88	99.20	13.0	51.5	27
	3B	0.14	64.24	31.02	1.92	1.88	99.20	13.0	51.5	27
	GP	0.35	56.63	38.81	0.27	1.80	97.86	15.1	53.5	33
	8A	0.34	64.22	31.03	2.46	1.63	99.68	14.9	58.3	30+
5	BS30	0.34	57.66	37.37	1.85	1.92	99.14	4.7	51.0	32
	2C	0.31	63.37	32.11	1.11	1.87	98.77	14.8	54.5	29
	BS30	0.32	57.38	37.35	1.79	1.90	98.74	4.7	51.0	32
	3B	0.14	64.24	31.02	1.92	1.88	99.20	9.5	71.2	27
	1D	0.18	70.36	25.40	1.82	1.56	99.32	14.1	64.5	28
	1G	0.34	57.66	37.37	1.85	1.92	99.14	12.5	57.5	32
	1H	0.32	57.38	37.35	1.79	1.90	98.74	12.9	58.2	32
	RAC							11.0	79.0	
6	RSC							9.7	67.7	
	3E	0.14	64.24	31.02	1.92	1.88	99.20	14.2	68.1	27
	1E	0.18	70.36	25.40	1.82	1.56	99.32	14.5	63.1	28
	3C	0.14	64.24	31.02	1.92	1.88	99.20	13.6	54.0	27
	MA[4]									

	B57	0.18	70.36	25.40	1.82	1.56	99.32	12.6	50.7	28
	RAF	0.32	9.34	89.16	0.25	0.50	99.57	7.6	62.7	
	RSF	0.26	29.52	68.94	0.45	0.32	99.49	15.2	74.4	
7	GA2	0.21	53.43	43.76	0.79	1.47	99.66	16.8	67.2	
	M55[4]									
	GA1[4]									
	L30[4]									
8[4]										
	A	No data on chemical composition						14.6	89.1	
	B	"	"	"	"	"		13.7	87.6	
9	C	"	"	"	"	"		12.0	91.7	
	D	"	"	"	"	"		10.7	89.7	
	E	"	"	"	"	"		([5])	([5])	
	F	"	"	"	"	"		([5])	([5])	
	G	"	"	"	"	"		4.2	95.2	

[1] Expressed as percentage of total absorption.
[2] Analysis same as 1B.
[3] Analysis same as 9A.
[4] No data.
[5] Same as 10B.
[6] Negligible.

tion between either chemical composition or porosity and resistance to glass attack. The effect of homogeneity of a refractory on its resistance to glass must be considerable and has as yet no satisfactory means of measuring homogeneity has been devised. Many instances of disintegration of tank blocks by pitting are shown in the photographs. Such pitting may be the result of (1) the presence of numerous coarse pores in the block, (2) a decided difference in composition between grog and bond, or (3) lack of adherence between the particles in the refractory. To be able to determine by physical and chemical tests alone the resistance of a refractory to glass action, suitable methods of measuring the properties enumerated above must be devised and the relative importance of these properties in providing resistance to the action of molten glass must be determined.

Acknowledgments are due R. F. Geller for his part in this investigation. The program was outlined by him and the entire investigation up to and including the run of the ninth tank was under his direct supervision.

SOME PUBLICATIONS YOU SHOULD OWN

Issued by

THE AMERICAN CERAMIC SOCIETY

(1) Branner's Ceramic Literature (1906)
451 pages. Titles only. $ 0.50

(2) Refractories: Silica, Magnesite, and General (1925)
330 pages. Titles and abstracts. 2.00

(3) Collective Index for Transactions
Volumes I to XIX, inclusive. 0.50

(4) Scumming and Efflorescence Bibliography
Reprints from Vol. 8, No. 8, 1925. 23 pages. No charge

(5) Standard Methods and Specifications
Ceramic Materials and Products (1928). 230 pages. 2.00

(6) Seger's Collected Writings
2 Volumes. 15.00

(7) Enamel Bibliography (1928)
500 pages. 2.00

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

ROSS C. PURDY, Editor

ROMA MARGRAF
EMILY C. VAN SCHOICK } Asst. Editors

ABSTRACTORS: C. R. AMBERG, A. A. AYARS, R. BARTA, G. A. BOLE, W. M. CLARK, L. P. COLLIN, R. G. EHMAN, T. W. GARVE, F. P. HALL, R. A. HEINDL, E. B. HEWITT, H. INSLEY, S. KONDO, A. I. KRYNITSKY, J. T. LITTLETON, JR., M. E. MANSON, A. J. MONACK, RALPH J. PADDOCK, L. A. PALMER, E. P. REXFORD, R. D. RUDD, D. E. SHARP, R. F. SHERWOOD, H. H. STEPHENSON, E. J. VACHUSKA, M. G. WESTFELDT, A. E. R. WESTMAN.

Vol. 8 **February, 1929** **No. 2**

Author Index to Ceramic Abstracts for February[1]

AUTHOR	PAGE
Adams, L. H.	148
Aktiselskapet Norsk Aluminum Co.	152
Anderson, J. A.	100
Austin, A. O.	134, 135
Bach, R. F.	87
Bahr, H.	141
Bain, W.	145
Balz, G. A.	118
Bansen, H.	118
Barker, W. M.	140
Barnes, W.	139
Batsen	118
Baule, B., and Benedetti-Pichler, A.	150
Baum, K.	118
Benell, J. A.	145
Berard, J., and Bodin, V.	156
Berry, H. H.	137
Blacke, H.	156
Blair, J. C.	107
Bleecker, W. F.	127
Bley, F.	144
Boas, F.	155
Bodin, V.	156
Bodin, V., and Gaillard, P.	142
Bohner, C. C.	109
Bole, G. A.	116
Bollenbach, H., and Kieffer, E.	150
Bond, W. N., and Newton, D. A.	148
Borne-Bonet, A. de S.-E.	141
Boswell, P. G. H.	146
Bottome, E. M.	90
Brero, F.	140
Brewer, A. K.	147
Briggs, B. A.	155
Brigham, A. P.	146
British Hartford-Fairmont Syndicate, Ltd., Wardley, T., and Renn, H. V. E.	113
British Science Guild	154
Brock, H.	136
Brown, E. T.	108
Brown, W. F.	107
Brownlie, D.	140, 141
Burlew, G. O.	85
Burt, F. M.	97
Callan, T., and Horrobin, S.	149
Capers, J., Jr.	105
Carborundum Co., Ltd.	86, 144
Carnegie, F., Masters, G. F., and Moorhead, R.	87
Carpmael, A.	137
Casselman, E. J.	127
Churchill Machine Tool Co., Ltd., and Asbridge, H. H.	87
Clare, R. L., Brown, G. H., and Allen, F. B.	127
Clark, G. L.	147
Clark, J. B.	90
Clark, V. S.	156
Cole, L. H.	145
Collins, P. F.	133
Coulthon, A.	142
Cramer, A. N.	108
Crane, C. R.	90
Curran, J. P.	90
Dalbey, G. E.	151
Damour, E., and Roszak	119
Damour, E., and Thuret, G.	106
Darke, W. F., and Lewis, E.	154
Davis, H. W.	146
Dean, F. W.	155
Dearborn, R. J.	152
Deeds, C. L.	133
De Lan, E. A.	90
Deurvorst, D.	100
Dickey, R. S., and Carnahan, P. A.	135
Dienemann, W.	144
Donaldson, J. W.	99
Dornedden, C.	130
Dorsey, N. E.	148
Drowns, E. E.	85
Dunbar, H. W.	84
Dupuy, E. L.	122
Dyhrberg, L. N.	117
Editorial	152
Eisenmann, J.	116
Eitel, W.	84
Ellis, B. F.	139
Emerson, D. B.	156
Endell, K., and Steger, W.	118
Engman, L.	85
Evans, J. W.	151
Ewald, W.	139
Fansler, P. E.	156
Feret	93
Fessler, A. H., and McCaughey, W. J.	144
Fisher, E. L.	141
Forster, F. A.	132
Fromme	138
Frois, M.	156

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

The bold-face number following the journal name is the volume; the issue number is in brackets, followed by the page numbers, then the year in parentheses.

AUTHOR	PAGE
Funk	154
Furnas, C. C.	147
Gilardoni, H.	116
Gilchrest, G. I.	135, 136
Gilmore, L. E.	99
Gimson, J. F., and Baker & Co., Ltd.	91
Glass, F. A.	116
Gordon, C. S.	136
Grant, J.	149
Greeley, W. R.	129
Greene, B. H.	143
Groum-Grjimailo, W. E.	118
Grunwell, P. C.	113
Hafner, W.	85
Hallows, R. L.	103
Halstead, F.	129
Hanausek, T. F.	151
Hanson, A. J.	127
Hanson, B. M. W.	86
Harr, K.	127
Harris, R.	101
Hartmann, M. L., and Westmont, O. B.	119
Heim, L. R.	85
Hein, L.	154
Henry, S. T.	139
Herberg, G.	156
Hintz, T. F.	141
Hopfer, R.	89
Hunt, S.	109, 110, 111, 112
Hutto, M. C.	86
I. G. Farbenindustrie Akt.-Ges.	151
Illies, H.	140
Irving, D. R., and Dietrich, W. F.	146
Jacobs, O.	119
Jaeger, M.	108
Johnson, F.	99
Johnson, J. Y.	151
Jourdain, A.	121
Jüptner, F. V.	140
Kameyama, N., and Masuda, E.	149
Kameyama, N., and Oka, S.	148
Kasai	154
Kauffmann, O.	130
Keil, C. R.	90
Keiser, H. D.	95
Kingsley, C. B.	106
Kirkpatrick, F. A.	131
Kirnick, W.	140
Klar, H.	118, 141
Koppa, G.	144
Kraner, H. M., and Fessler, A. H.	133
Kraner, H. M., and Fritz, E. H.	129
Krause, O.	133
Kreidl, I.	100, 101
Kunstzahn Ges.	137
La France, R.	107
Lai, C. F., and Silverman, A.	105
Lamotte	156
Larochelle, E.	144
Larson, D. B.	140
Laubenheimer, A.	144
Lax and Shaw, Ltd., Shaw, J. F., and Branford, J. E.	110
Lee, P. W.	128
Lewis, E. I.	138
Lillibridge, H. D.	135
Lodge-Cottrell, Ltd.	140
Loundes, W. S.	156
Lowe, R. E.	127
Magee, W. H.	90
Mallet, P. M.	149
Martone, J.	86
Mattingly, N. B., and Rea, A.	113
McCreary, T. W.	90
McIntyre, W. A., and Zaiman, A.	128
McLaughlin, J. E.	107
Meade, R. K.	94
Mehling, C. W.	97
Mernagh, L. R.	100
Merriman, T. C.	90
Meyer, W.	105
Miall, S.	105
Middleton, J.	119
Miething, H.	105
Mighill, T. A.	140
Miller, F.	117
Mitchell, R. C.	85
Morley, R. B.	155
Nagai, S.	94
Nambourg, N.	107
Naylor, W. K.	134
Nicol, H.	89
Nixon, C. R.	109
Ogden, E. P.	142
Palmer, L. A.	113, 116
Papish, J.	145
Parker, E.	136
Patrouilleau, L. G.	127
Payne, H. M.	123
Pearce, J. C.	99
Peiler, K. E.	107, 108
Philpott, O. A.	141
Phoenix, E. A.	130
Pike, R. D.	117
Pike, R. D., and West, G. H.	105
Place, T.	132
Polgrean, J. H.	89
Pooley, H., Jr.	96
Port, P. J., and Newton, J.	109
Poste, E. P., Hansen, J. E., Harrison, W. N., and Rice, B. A.	96
Price, B. K.	85
Prouty, W. O.	132
Reece, J. A.	107, 108
Reiter, F. M.	140
Reitschel, H., and Barabee, C. W.	157
Revere, G.	94
Rewald, B.	100
Riedig	138
Roberts, F. H. H.	90
Roessler and Hasslacher Chemical Co.	152
Rogers, F. H.	154
Rohm and Hass A.-G.	110
Ross, D. W., and Lambie, J. M.	136
Roszak, C.	120
Rothe, F., and Brenek, H.	109
Rowe, G. E.	106
Ruff, O., and Hirsch, B.	150
Samuelson, A.	109
Schwarz, R.	147
Schuette, C. N.	119
Scott, V.	106
Searle, A. B.	93, 118, 125, 153
Sen, K. C.	150
Shugart, H. A.	117
Silk, K.	122
Simonds, H. R.	81
Smith, K.	131
Smithells, C. J., Williams, S. V., and Avery, J. W.	138
Soubier, L. D.	107
Spencer-Churchill, E. G.	143
Spinasse, A. E.	107
Stein, J. A.	139
Stokowy, H.	144
Straight, H. R.	143
Stuhlman, O., Jr.	155
Svedberg, T.	151
Swain, R. E.	101
Talley, R. E.	100
Teetor, P.	130
Thomas, W. N., and Davey, N.	114
Thomte, S.	82
Thompson, G. C.	90
Thompson, M. deK., and Armstrong, W. G.	149
Tomita, U.	90
Treadwell, F. P., and Hall, W. T.	151
Trethowan, H.	87
Turner, W. E. S.	104, 105

AUTHOR	PAGE
Umhau, J. B.	146
Underwood, A. J. V.	138
United Glass Bottle Mfrs., Ltd., and Moorshead, T. C.	112
Wallace, R. C., and Greer, L.	145
Warga, K.	90
Warnick, G. D.	117
Watson, F. J.	97
Weinland, H. G.	86
Wells, L. S.	91
Whitall Tatum Co.	112
White, A. E.	139
White, A. H., Aagaard, W. A., and Christensen, A. O. L.	96
Whiting, W. E.	81
Widemann R. V.	120
Willis, H. J.	83
Wolfram, H. G.	98
Zebisch, A.	132
Zeiss, C.	112

Abrasives

Abrasive skill in razor manufacturing. HERBERT R. SIMONDS. *Abrasive Ind.*, 9 [12], 315 (1928). E.P.R.

Care of industrial diamonds. ANON. *Abrasive Ind.*, 9 [12], 318 (1928).—Industrial diamonds are comparatively brittle so that due care should be exercised in applying them properly in a wheel-truing operation. These data and illustrations were prepared by the Wheel Truing Tool Co., Detroit. The industrial diamond depends for its value chiefly on its physical quality of hardness. It is true that diamonds vary slightly in this characteristic, but the difference between the hardest and softest is negligible. Stones are graded and priced according to size, origin, color, shape, cleavage, and imperfections. While the diamond is a very hard substance it is also brittle. This applies especially to bort stones with well-defined lines of cleavage. It is apparent, then, that in the use of a diamond, care should be exercised to guard it against shock. Another mistake in using a wheel-truing diamond is to bring it into contact with the wheel at a point above the horizontal center line through the wheel's axis. When this is done it is almost impossible to avoid dangerous shocks. Advance the diamond tool slowly until it touches the center of the face of the wheel. Flood wheel and diamond tool with cooling lubricant. Feed from center, first left, then right, until tool has completed a full pass of the wheel face. Advance tool 0.002 in. for each cut until wheel is trued. The cut is started always in the center of wheel face because usually the wheel is worn away more toward the corners. In truing a grinding wheel it is extremely important to take light cuts. E.P.R.

Economy in grinding cast-iron parts from rough castings. ANON. *Abrasive Ind.*, 9 [12], 320 (1928).—Overhead generally is a fixed charge that is not altered readily. The labor cost, however, can often be lowered materially by employing grinding on operations that are done on the planer or miller. A few interesting grinding jobs wherein the work is finished from rough castings are illustrated and described. E.P.R.

Cause of crankshaft grinding wheel breakage. W. E. WHITING. *Abrasive Ind.*, 9 [12], 322 (1928).—Confronted with the problem of grinding wheel breakage at the plant of a prominent manufacturer, W. made a careful investigation which resulted in some unusual findings that are given in detail. A complete analysis of the situation had to be made before operations could continue. The investigation started with the last wheel that had broken in the flanges just as it came from the grinding machine. The wheel was carefully examined and conditions noted before taking it from the flanges. The wheel broke into four segments while the operator was truing up the face. It was indicated that some foreign stress had been set up in mounting the wheels, and must have been caused by either the web of the wheel or the flanges. After making these deductions the segments were removed from the flanges, and each segment was carefully measured and checked in several places. This flange was found to be wavy and bore against the Perks safety washers at points along the inner edge near the six screws. The portion of the flange that fits in the hole of the grinding wheel had become enlarged and fitted rather snugly. Then tightening down on the screws would tend

to make it still larger, which in turn would tend to expand the hole in the wheel. As the wheel would not expand it simply cracked. The flange tapered as much as 0.015 to 0.02 in. To prove the theory that the wheels were cracked in mounting, a stub of an old wheel was taken that had a clear ring and mounted on the same flanges. It was gradually taken up a little at a time on each screw, and before much pressure had been applied, this wheel stub cracked. A new wheel was then mounted on the stub of the flanges. The sides of the web of this wheel were about 0.01 in. out of parallel. In mounting this wheel a blotter washer was placed next to the inner flange, then the Perks washer, next the wheel, followed by another Perks washer and blotter washer, and lastly the outer or ring flange. The twelve screws were drawn up as tight as possible which was tighter than necessary to hold the wheel; but still the pressure did not crack the grinding wheel. As all the wheel breakages at the plant in question had been on this type of flange, it was concluded that the trouble had been located; and it was strongly recommended that all flanges of this type be checked and the necessary steps taken to strengthen them. E.P.R.

Educational exhibit of abrasives. ANON. *Abrasive Ind.*, 9 [12], 323(1928).—The character and use of abrasive products forms one of the most interesting chapters of industrial history today for without modern abrasives and grinding machines it would be impossible to carry out present-day production schedules. A pictorial representation is to be found in Norton Hall at the plant of the Norton Co., Worcester, Mass. Three sides of Norton Hall are occupied with exhibition cases which form part of an excellent decorative scheme. Here are shown different abrasives and the materials from which they are derived, and the methods of manufacture of grinding wheels. There also are shown a variety of shapes and sizes of finished wheels, specimens of abrasive tile floors, refractories, tools, and machine parts produced with the aid of abrasive products. E.P.R.

Grinding operations in rapid transit car maintenance. B. K. PRICE. *Abrasive Ind.*, 9 [12], 325 (1928).—Although steel car wheels are now repaired by turning in preference to grinding, if painstaking tests were conducted under the direct supervision of trained abrasive engineers, the adoption of grinding in place of turning would naturally follow. The process of repairing steel wheels by turning is expensive and out of date. E.P.R.

Grinding wheel size for undercut conical surfaces. STEN THOMTE. *Abrasive Ind.*, 9 [12], 327 (1928).—A problem which now and then confronts the grinding engineer is to determine the size of wheel, which can be used when grinding undercut conical surfaces. One example of this is when grinding the inside face of the cone of a roller bearing. The writer has developed a simple general formula to be used in such cases: α is the angle between the side of the cone and a plane at right angle to the axis of the cone, β is the angle between the wheel and the axis of the cone, and b is the distance from the edge of the wheel to the axis of the cone. For the solution of the problem, complete the cone and extend the sides to make a double cone. Consider the wheel as a disk without any thickness and extend the plane in which this disk revolves. The section between this plane and the just constructed double cone is a hyperbola, one axis of which is the distance AC. An intersecting plane through the apex of the cone will give two lines, parallel to the asymptotes of the hyperbola. If the equation of a hyperbola is $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ then the expression for the radius of curvature at any point is $p = a^2b^2\left(\frac{x^2}{a^4} + \frac{y^2}{b^4}\right)^{3/2}$. We are only interested in the radius of curvature at the vertex, and by inserting the coördinates $x = a$, $y = O$, we arrive at $p = \frac{b^2}{tg\alpha}$. This

formula is valid only when the wheel is parallel to the axis of the cone. If a line OD is drawn parallel to CA and the right triangle ODA completed it is found that the distance OD is, $OD = m = \frac{b \sin(\alpha + \beta)}{\cos \alpha}$. Then $n = \sqrt{\frac{b^2 \sin^2(\alpha + \beta) \cos^2 \beta}{\sin^2 \alpha} - \frac{b^2 \sin^2(\alpha + \beta) \sin^2 \beta}{\cos^2 \alpha}}$, or developed $n = \frac{b \sin(\alpha + \beta)}{\sin \alpha \cos \beta} \sqrt{\cos(\alpha - \beta) \cos(\alpha + \beta)}$. As the section between the plane OD and the surface of the cones is two lines parallel to the asymptotes of the hyperbola we have that $\frac{b_1}{a_1} = \frac{n}{m}$, where b_1 is the short axis of the hyperbola. If the triangle AOC is studied it is found that the angle at O is 2α and the angle at C is $[90 - (\alpha - \beta)]$. The side AO is $\frac{b}{\cos \alpha}$. Using the sine theorem we have $a_1 = \frac{b \sin \alpha}{\cos(\alpha - \beta)}$. Substituting these values gives $b_1^2 = a_1^2 \frac{\cos(\alpha - \beta) \cos(\alpha + \beta)}{\sin^2 \alpha}$. To find the radius of curvature at the vertex substitute the above in the formula $p = \frac{b^2}{a}$ and solve, $p = b \frac{\cos(\alpha + \beta)}{\sin \alpha}$. This is the general formula which answers to all conditions and by inserting $\beta = 0$ we find that $p = \frac{b_1 \cos \alpha}{\sin \alpha} = \frac{b_1}{tg\alpha}$. p is the maximum wheel radius which can be used for grinding the conical surface and produce a perfect cone shape. E.P.R.

Acquire abrasive lines. ANON. *Abrasive Ind.*, 9 [12], 329 (1928).—The U. S. Sand Paper Co., Williamsport, Pa., will expand its line of abrasive coated paper and cloth products through the purchase of the Federal Abrasive Works, Inc., Westfield, Mass. and the Standard Abrasive Co., Inc., Garfield, N. J. E.P.R.

Setting up wheels. ANON. *Abrasive Ind.*, 9 [12], 332 (1928).—Before setting up polishing wheels, in some cases the old grain and glue must be removed. One method to follow is to use a polishing wheel cleaning device which consists of two rollers on which the wheel sets. The bottom of the wheel touches the surface of water placed in a trough under the rollers. One of the rollers is rotated slowly for power. In some instances the abrasive is rolled into the glue under pressure. The abrasive material should be kept in covered receptacles for if a small amount of coarse grain becomes mixed with the finer number, wheels set up with the material invariably will leave deep scratches. E.P.R.

Manufactured abrasives in gear lapping. H. J. WILLIS. *Abrasive Ind.*, 9 [12], 332 (1928).—Although gears and gear making methods have been given considerable thought and attention for many years, the process of gear lapping practically has been neglected. W. reviews the various abrasives used in gear lapping such as ground glass, crystallized aluminia, tripoli, corundum, and silicon carbide. This list includes both natural and manufactured abrasives, the manufactured abrasives being considered the best for gear lapping. Consideration is given also to the vehicle for carrying the grain. E.P.R.

Heavy duty knife and face grinder. ANON. *Abrasive Ind.*, 9 [12], 340 (1928).—In all face grinding operations, whether it is shear blades, various other machine knives, or miscellaneous face grinding, in order that the best may be obtained in speed and economy, the right work speed must be used. Good accurate grinding requires that the work be kept cool. This can be done only by the proper work speed, in conjunction with adequate coolant. Furthermore, to obtain abrasive economy, the abrasive wheel must not be made to take cuts deeper than its proper chip depth. Otherwise the

abrasive is merely torn out and turned into refuse without having performed its proper function. The proper work speed varies much, due to different materials, degrees of hardness and character of surface. Here all speeds from minimum to maximum are directly at hand by merely turning a handwheel and all are indicated on the speed dial. A heavy duty knife and face grinder recently developed by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn., is discussed in detail. E.P.R.

Hone brake drums. ANON. *Abrasive Ind.*, 9 [12], 341–42 (1928).—Brake drums can be refinished on the appliance illustrated without removing the tire or rim. The machine has been introduced by the Reed-Prentice Corp., Worcester, Mass., and it is intended for automobile service stations. A honing tool may be supplied, which consists of a bar fitting into the tool block the same as the cutting tool, and which holds two honing stones to finish the outside and inside of the drum. E.P.R.

Core grinder. ANON. *Abrasive Ind.*, 9 [12], 342 (1928).—A novel machine recently introduced by the Stoney Foundry and Engineering Co., Cleveland, levels foundry cores in less time than formerly required when fitted by filing. The machine will grind a number of cores simultaneously. E.P.R.

Test and lap gears. ANON. *Abrasive Ind.*, 9 [12], 342 (1928).—The Gleason Works, Rochester, N. Y., recently designed an 18-in. combination testing and lapping machine for spiral bevel and hypoid gears. E.P.R.

Importance of details in grinding. H. W. DUNBAR. *Fisher's Machinery Guide*, **10** [11], 46–47 (1928).—The importance of such things as perfect wheel-balance is emphasized. H.H.S.

Production of abrasives in 1927. ANON. *Eng. Min. Jour.*, **126** [3], 98 (1928).—The production of miscellaneous natural abrasives sold by producers in the U. S. in 1927 is shown in the table.

Abrasive	Short tons	Value
Emery	506	$ 5,855
Garnet	6,939	573,525
Grinding pebbles, tube-mill lining	3,342	46,856
Grindstones	23,682	659,007
Millstones, chasers, dragstones		35,438
Oilstones, whetstones, hones, scythestones, rubbing stones	932	233,080
Pulpstones	8,249	895,743
Pumice	53,298	221,481
Tripoli	26,099	447,068

Artificial abrasives sold during the year included 26,289 T. of carbides, valued at $2,603-571; 50,973 T. of aluminum oxides, valued at $4,516,637; and 13,364 T. of metallic abrasives, valued at $839,683. A.J.M.

Physico-chemical principles of grinding materials. WILHELM EITEL. *Z. Ver. deut. Ing.*, **72**, 1155–57 (1928).—Not only hardness, but cleavage, tensile strength, brittleness, structure, and other properties must be considered in determining the value of grinding materials. The crystallization of a material from its molten state must be controlled carefully so as to produce the form of abrasive desired; this necessitates the use of correct phase diagrams. The binding materials used are of great importance also. Although artificial diamonds have not been prepared on a large scale this is no proof that they may not be available in the future, for other problems seemingly as difficult have been solved. The influence of SiO_2, MgO, CaO, etc., on the composition and properties of the crystals or mixed crystals produced in making alundum and other forms of Al_2O_3 is shown by diagrams and photomicrographs. In SiC the form of the crystal lattice is important in fixing the properties of the abrasive. Although the materials known to make good abrasives are few in number new substances showing promise of usefulness include certain Al silicates, W carbides, etc. (*C.A.*)

PATENTS

Grinding device. LEWIS R. HEIM. U. S. 1,691,061, Nov. 13, 1928. In grinding apparatus, in combination, a work supporting member having a recess throughout its length, and a wear-resisting member fitted into and interlocked with the supporting member substantially throughout its length and adjustable with respect thereto about its longitudinal axis to change the surface exposed for wear.

Abrasive wheel. GILDEROY O. BURLEW. U. S. 1,692,329, Nov. 20, 1928. A grinding wheel comprising an abrasive substance in powdered form, chopped sponge incorporated therewith, and a binder of rubber vulcanized with the abrasive and sponge.

Grinding machine. EDMOND E. DROWNS. U. S. 1,692,769, Nov. 20, 1928. (1) In a grinding machine having a shiftable table, a grinding wheel, and means for driving it, the combination of supporting means carried by the table, a pair of opposed ball seats carried by the supporting means, shiftable toward and from each other, a bracket swingable about an axis common to the ball seats, a rotatable shaft carried thereby and having its axis transverse to the axis of the ball seats so as to be capable of occupying a position radial to the axis of the ball seats means for driving it, and a work holder carried by the shaft for carrying the work in position to be positioned between the ball seats, the relation of the parts being such that the spherical portion of the work may be steadied by the ball seats but rotate with the shaft therebetween and also given an angular movement about the axis of the seats. (2) In a grinding machine having a shiftable table, a grinding wheel, and means for driving it, the combination of supporting means carried by the table, a pair of opposed ball seats carried by the supporting means, one located above the other and shiftable toward and from the other, a bracket swingable about an axis common to the ball seats, a rotatable shaft carried thereby and having its axis transverse to the axis of the ball seats so as to be capable of occupying a position radial to the axis of the ball seats, means for driving it, and a work holder carried by the shaft for carrying the work in position to be positioned between the ball seats, the relation of the parts being such that the spherical portion of the work may be steadied by the ball seats but rotate with the shaft therebetween and also given an angular movement about the axis of the seats, the shaft and work holder having a pin and slot connection to permit longitudinal movement of the work holder, thereby to assist in centering the work between the ball seats, the driving means for the shaft being carried by the swinging bracket.

Roll-grinding apparatus. LEWIS R. HEIM. U. S. 1,692,833, Nov. 27, 1928. In combination, a grinding wheel, a regulating wheel, a pair of telescoping hoods, one for each of the wheels for substantially enclosing the wheels, a carrier extending between the wheels for supporting cylindrical bodies in operative relation thereto, and means for adjusting one of the hoods toward or away from the other.

Composition of matter for use in honing razors and other knives. WILHELM HAFNER. U. S. 1,693,697, Dec. 4, 1928. A composition of matter for honing, consisting of a mixture containing glue, glycerine, and powdered emery and tripoli.

Grinding machine. RAYMOND C. MITCHELL. U. S. 1,693,723, Dec. 4, 1928. In a grinder, the combination of a slide-table, a grinding-wheelstand, cross-feed mechanism for the latter, having a shiftable part, automatic means for reciprocating the table, the table reciprocating means having operative connections to actuate the cross-feed mechanism, a constantly-moving part and means operatable from the constantly moving part for actuating the cross-feed independently of table-reciprocation, the shiftable parts being movable to render idle either operating mechanism alternatively.

Grinding tool. LOUIS ENGMAN. U. S. 1,693,778, Dec. 4, 1928. A tool for grinding cylinders comprising a tubular body having a central bore and spaced grooves in its periphery, the body having radial openings connecting the grooves and the bore, holders

for grinding elements slidable radially in the grooves and having lugs extending through radial openings into the bore, end members covering the opposite ends of the tubular body and having portions retaining the holders against longitudinal movement in the grooves, one end member having an axial hub extension outside the tubular body, the end members having aligned central bores, the hub having an arcuate slot extending from the bore of the associated end member through the outer wall of the hub, a rotary cam shaft extending through the bore of the tubular body and having end portions journaled in the bores or the end members, the cam shaft having spaced cams in contact with the inner ends of the lugs of the holders, a coil spring encircling the cam shaft and having one end secured to the cam shaft and its opposite end secured to the tubular body, a radial pin extending through the slot in the hub and secured to the adjacent end of the cam shaft, a set screw threaded through a radial opening in the hub and adjustable to and from position to lock the cam shaft against turning in the hub, and a ring adjustable circumferentially on the hub and having a pair of shoulders adapted to be engaged by the outer end portion of the radial pin to limit the turning movement of the cam shaft in opposite directions about its axis when the set screw has been loosened, the coil spring being adapted to be placed under tension when the cam shaft is turned in the direction required to permit inward movement of the holders in the grooves of the body and then tending to turn the cam shaft in the opposite direction about its axis.

Machine for grinding gears. BENGT M. W. HANSON. U. S. 1,693,781, Dec. 4, 1928. In a machine for grinding toothed gears, an abrasive screw having a thread of uniform outside and root diameters and corresponding in pitch to the circular pitch of the gear to be ground and uniformly corresponding in normal cross-section to a rack tooth adapted to properly mesh with the teeth of the gear to be ground, means for rotatably supporting the toothed gear to be operated upon, and means for driving the abrasive screw and the supporting means, the abrasive screw being mounted for angular adjustment about a line normal to its axis whereby the convolutions on the abrasive screw where they engage the gear will be in proper relation to the teeth of the gear.

Attachment for grinding machines. JEREMIAH MARTONE. U. S. 1,694,074, Dec. 4, 1928. In a work holder for guiding a spiral milling cutter while the latter is being ground by a rotating grinder, a vertical post adapted to be held stationary upon the lower table of the machine, a lower clamping block slidable vertically upon the post and carrying an adjustable inclined arm, means for holding the inclined arm in adjusted position, and upper clamping block slidably and rotatably mounted on the upper part of the inclined arm, a horizontal work-guiding finger carried by the upper clamping block, means in front of the upper block for minutely adjusting the work-guiding finger toward and away from the work.

Grinding machine. HERMON G. WEINLAND. U. S. 1,694,340, Dec. 4, 1928. In a grinding machine, a grinding wheel, a constant speed motor for driving the wheel, and means controlled by the size of the wheel to prevent operation of the wheel at peripheral speeds other than predetermined speeds.

Self-dressing abrasive articles. CARBORUNDUM CO., LTD. Brit. 273,679, June 10, 1927. The articles comprise uniform grains of abrasive material and of friable material sufficiently hard to break out of the mass without "glazing" the surface (*e.g.*, calcined clay grog) and binding material (*e.g.*, clay, feldspar, synthetic resins, glue, etc.).

(*B.C.A.*)

Grinding cylinders. M. C. HUTTO. Brit. 296,619, Oct. 31, 1928. A cylinder grinder comprises a number of radially disposed abrasive blocks urged inward by garter springs and abutting against lugs on the edge of plates fixed in radial slots in top and

bottom rings integral with the body, each plate having tapered projections abutting against a pair of cones which are hand adjusted toward each other against spring pressure by the screw and head to force the blocks outward against the cylinder walls. If the cylinder walls are out of the true circular one end of the stone may be thus tilted in and the other end out, which causes the two cones to move axially as one element along the base to a new position of bearing pressure, and so allowing freedom of the stones to adjust themselves and so prevent them binding. When the blocks have ground themselves free they are again adjusted by screwhead. To hold the plate in position without material longitudinal movement, hardened pins with countersunk heads are inserted near the end of each slot in the ring, the pins abutting against the high points on the sides of the plate to allow the plate to tilt. The stone carriers have projections with rounded ends which fit between the rings.

Grinding cylinders internally. F. CARNEGIE, G. F. MASTERS, AND R. MOORHEAD. Brit. 296,738, Oct. 3, 1928. A cylinder having a long bore is ground by means of a grinding wheel mounted on a spindle which is carried in bearings in a sleeve secured in plates. The plates have parts eccentric to the sleeve and the parts are mounted in seatings formed eccentrically of an outer sleeve running in bearings by rotation of the plates in the sleeve. The grinding wheel is adjusted to the diameter of the cylinder, bolts serving to secure the plates in adjusted position. The sleeve is rotated at a speed slower than, and in direction opposite to, that of the grinding wheel, and the cylinder is reciprocated during grinding. To prevent vibration of the wheel spindle and sleeve the sleeve has supplied thereto, through an inlet and a passage in the spindle, fluid under pressure; an outlet may be provided for allowing the passing of the fluid to the tool.

Grinding rollers. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 298,035, Nov. 21, 1928. In a machine for grinding rollers having a parallel, a convex, or a concave form, a roller is mounted for rotation on a support pivoted to a table which is reciprocated on the machine bed by a rack and a pinion. The support is oscillated on its pivot, to give the required longitudinal contour to the work, by a second rack slidable in the table and driven by a pinion and having attached thereto a block slidable on the table and carrying an adjustable grooved disk. The groove in the disk is engaged by the end of a lever which also engages and oscillates the support, the extent of oscillation depending on the angular setting of the groove in the disk; a link and a 2nd lever insure correct movement of both ends of the support. In place of the rack gearing, screw gearing or a hydraulic drive may be used.

Art

Modern industrial potteries. HARRY TRETHOWAN. *Creative Art*, 3 [3], 176–82 (1928).—Examples of domestic ware are shown and though they are inclined to be bulky there is still an artistic touch. Copeland, Spode, Cauldon, and Worcester show sincerity and character in their work. Gray and Hanley have interesting lusters. Ashtead Guild of Disabled Soldiers is producing opaque white earthenware worthy of the collector. Cauldon Works have established an industry with a background of art training and experience. Joseph Burton in his production of Royal Lancastrian ware retains the essentials and fundamentals of the potter in his hand-thrown Lapis ware. Modern commercialism need be no bar to artistic production, although much of the work is by no means worthy. M.G.W.

Better design. RICHARD F. BACH. *Glass Ind.*, 9 [11], 251–55 (1928).—Manufacturer, dealer, school of design, and the purchasing public, all are parties to what has been termed a conspiracy against public taste. No remedy proposed can be successful

if its effect is to be that of a caustic. The cure must be gradual. The manufacturer should be willing to coöperate with schools of design, to serve on their directing boards, advising in the preparation of programs of study; also to aid the general purpose by admitting to his designing rooms graduating students (in the semester or year preceding commencement) as apprentices on part or full time with periodic instructional visits to his factory, so that design may always be visualized as unhampered by the limitations of portraiture and the obstacles presented by paper and tubes of color. He should be willing to grant his designers time on pay to study their current problems in terms of the best sources in nature and in museums and libraries, to meet them himself regularly in group conferences to inform them as to market conditions, provide them with both art and trade journals, and more than occasionally turn out objects designed by them, or by others, which are beyond the bread-and-butter type of commercial achievement. The dealer, in turn, should be willing to instruct his buyers and his salespersons as to the importance of design as a selling factor, profiting through courses offered by museums, schools, or individually employed experts to obtain the necessary guidance. He should be willing to handle certain commodities which are unquestionably of fine design though not sold in quantity or even at reasonable profit. His window display, advertisements and price cards should announce that his sales are based on design as well as material, serviceability, and price. To prove his sincerity he should be willing to employ an art director, regularly or on special terms, to supervise all such matters and advise in the correct appearance of his establishment and ware before the public. But the training of taste in his buyers and salespersons should be his primary concern. Schools of design, as a group, are out of tune with present needs and practices in industrial art. Practical experience will show what happens to art in quantity production. They need actual installation of machinery in the school, the execution of designs under the maker's personal supervision in a working plant. Schools of design will in future study market demands, teach design for industry in terms of what will sell, always with an eye toward bettering factory output. Again, schools will coöperate with manufacturers and dealers, asking their advice (and following it) and selling to them designs immediately useful with minimum modification. For the students of industrial design, schools will be closely related to selected firms, so that prospective graduates can finish their schooling with a stated period of factory or store employment, in close contact with the realities of art in labor. Finally, to aid both manufacturers and dealers, schools can with profit offer continuation courses on various aspects of art useful in production and trade. E.J.V.

Accurate determination of color. ANON. *Glass Ind.*, 9 [12], 280 (1928).—The problems of matching colors in railroad and highway signal lights, tableware, and other glass products has been a serious one. Heretofore colorimeters of various types have been employed to some extent as an aid to the glassmaker. Recently, however, a new instrument has been developed which gives promise of solving the problem completely. The exact duplication of a color at any time and place has been made possible by a new colorimeter developed by Arthur C. Hardy of the department of physics at Massachusetts Institute of Technology. The new color analyzer, known as a recording spectrophotometer, eliminates human judgment entirely, and automatically measures the color and wave lengths rapidly and with precision. Not only does it measure color accurately, but it makes a record by which it is possible to match that shade at any time, thus eliminating all possibility of fading of a standard color. The principles on which the instrument operates are explained in detail. The importance of the new color analyzer lies in its value to industry in nearly every branch of which control of the color of its products is necessary. There is scarcely an industry without a color problem. The color of a product is one of the properties which many manufacturers attempt to

control in order to please the retailer or the consumer. The desirability of uniform color applies in manufacturing such products as glass, tile, pottery, and many others. Since the instrument has been developed, there has not been sufficient time to test its applicability to all of the industries in which it is expected to be of service; but sufficient tests have been made to indicate that the instrument will be of use in many different kinds of work. E.J.V.

Selenium red as ceramic color. J. H. POLGREAN. *Pottery Gaz.*, **53** [618], 1921 (1928).—Basing experiments upon work done some years ago by Granger, of Paris, bearing more directly upon the use of selenium in glass manufacture and the enameling of steel, it was endeavored (1) to produce the red color, and (2) to build up a flux which would favor the color and which could be suitably applied to pottery. The earliest experiments consisted of mixtures of oxide of selenium and cadmium sulphide in varying proportions, the calcination being performed in an ordinary gas muffle. The temperature never exceeded a dull red heat, and for a time a thermocouple and Watkin's heat recorders were used to indicate the temperature. It soon became evident that temperature was a potent factor in the production of the color, because it was found that whenever the desired color was obtained it could easily be destroyed by merely increasing the temperature. The most successful of the mixtures tried was one which contained 20% selenium and 80% cadmium sulphide. The color of the mixture, when hot, was brown to black, but as the cooling took place the red coloration began to show through. In the search for a suitable flux it was discovered that borax seemed to favor the color more than anything else, but, as it was impossible to use a flux containing borax only, attempts were made to build up a leadless flux which would fuse successfully at kiln temperature, about 700°C. The flux had to be soft enough to fuse at kiln temperatures, beyond which the color could not be retained. Small additions of lead to the flux were made in the hope of improving its working properties, and it was found that a small percentage of lead did not interfere with the color, though disastrous results occurred by adding too much lead. The best results were obtained when the color was applied to the ware on a biscuit surface; better still were the results if the ware had a porous surface. It was essential to have a good depth of color, and this could be obtained more easily on a biscuit or porous surface than on a glazed surface. Important points in successful production of selenium red for pottery coloration were careful calcination and constancy of composition in the materials employed. An excess of flux and depth of color were essential. The color would not withstand a temperature exceeding that of the ordinary enamel kiln, which precluded the possibility of using selenium as the constituent of a colored glaze for tile decoration. E.J.V.

Glassware by modern artists. ANON. *Ceram. Ind.*, **11** [6], 568–69 (1928).—Some of the newest types of glassware manufactured by the Corning Glass Works, Steuben Division, were recently displayed at the company's display room at New York. Much of the ware shown contain some ideas in shaping and decoration entirely new in the industry and a study of the photographs will no doubt offer ideas for artists to develop. Domestic glassware and dinnerware are showing considerable progress in new designs and decorations which are presenting a formidable competition to imported ware. F.P.H.

Colloidal gold. HUGH NICOL. *Chem. and Ind.*, **47T**, 343–44 (1928).—A gold sol of pure red color is obtained by adding a 0.15% solution of "hyperol" (an equimolecular compound of urea and H_2O_2) in alcohol to a solution of a gold salt. H.H.S.

Metal spraying. R. HOPFER. *Chem. and Ind.*, **47**, 1215 (1928).—In metal-spraying processes now in use, a wire of the metal is melted by an oxyhydrogen flame, and simultaneously sprayed by means of compressed air, the dispersed metal forming a deposit on the object to be treated. All metals which can be prepared in the form of wire

and which melt below 1600°C may be so dispersed, though the porosity of the deposit renders the process unsuitable in some cases. The coating may be as thin as 0.02 mm. H.H.S.

The preservative side of archaeology. ANON. *Illust. London News*, **173**, 879 (1928).—Photographs are shown of methods adopted at the German Museum in Berlin for preservation of antiquities. Glazed ware is washed free from soluble salts in tubs and, when dry, is saturated with paraffin. The reconstruction of what has fallen to pieces is difficult and tedious. A photograph is given of an Assyrian dragon on a section of wall pieced together from countless fragments. H.H.S.

Prehistoric pottery in Colorado. F. H. H. ROBERTS. *Science Supp.*, **68**, 14 (Oct. 12, 1928).—A village on the Piedro River which was laid waste by fire 2000 years ago has yielded 250 pieces of pottery and other finds. The discovery confirms the view that the basket-maker Indians, who preceded the cliff-dwelling Pueblos, did not perish suddenly as a race, but mixed peacefully with the Pueblo tribes and gradually lost their identity. H.H.S.

Pottery training at Haileybury. ANON. *Times* (weekly edition), **61**, 492 (1928).—A pottery has been started at the well-known "public school" Haileybury College, Hartford, England. As training for hand and eye, the craft of pottery is considered particularly valuable. Photographs of boys at potter's wheel and glaze kiln are included. H.H.S.

Applying glazes and enamels on glasses. ANON. *Sprechsaal*, **61** [30], 581–83 (1928).—A discussion of the patented processes used in America and Germany for applying glazes and enamels to glasses. R.A.H.

PATENTS

Ornamental design for goblet. EDGAR M. BOTTOME. U. S. 76,852, Nov. 13, 1928.

Ornamental design for goblet. CHARLES R. KEIL. U. S. 76,873, Nov. 13, 1928.

Ornamental design for bowl. WILLIAM H. MAGEE. U. S. 76,878, Nov. 13, 1928.

Ornamental design for bowl. WILLIAM H. MAGEE. U. S. 76,879, Nov. 13, 1928.

Ornamental design for candlestick. WILLIAM H. MAGEE. U. S. 76,880, Nov. 13, 1928.

Design for plate. EDGAR M. BOTTOME. U. S. 76,913, Nov. 20, 1928.

Design for lavatory. CHARLES R. CRANE. U. S. 76,917, Nov. 20, 1928.

Design for lavatory. CHARLES R. CRANE. U. S. 76,918, Nov. 20, 1928.

Design for plate. EUGENE A. DE LAN. U. S. 76,919, Nov. 20, 1928.

Ornamental design for covered dish or analogous article. GEORGE C. THOMPSON. U. S. 76,963, Nov. 20, 1928.

Ornamental designs for plates. URASABURO TOMITA. U. S. 76,964–72 (9 patents), Nov. 20, 1928.

Ornamental design for tumbler. JEDDIA B. CLARK. U. S. 76,985, Nov. 27, 1928.

Ornamental design for tumbler. JEDDIA B. CLARK. U. S. 76,986, Nov. 27, 1928.

Ornamental design for bottle. JEROME P. CURRAN. U. S. 76,990, Nov. 27, 1928.

Ornamental design for fishbowl. THOMAS W. MCCREARY. U. S. 77,018, Nov. 27, 1928.

Ornamental design for covered dish. THOMAS C. MERRIMAN. U. S. 77,021, Nov. 27, 1928.

Method of decorating glass surfaces. KALMAN WARGA. U. S. 1,693,735, Dec. 4, 1928. Method of fixing designs on glass objects, which consists in (1) forimng the design in color films containing each a mineral pigment and a vitreous binding material, the films being all fusible at the same temperature, (2) placing the design in a mold fitting the glass object, (3) inserting the glass object in its hot state into the mold

in contact with the design, and (4) fixing by heat the films to the glass object while the latter travels within the mold through a leer.

Ornamenting pottery surfaces. J. F. GIMSON AND BAKER AND CO., LTD. Brit. 298,018, Nov. 21, 1928. The surfaces are made with slight indentations, recesses, or irregular cavities, and are painted in ceramic colors while the articles are in the clay or bisque state, and then are glazed and fired. Or the indented bisque ware may be glazed, then painted in colored slip and again glazed. The flat portions and cavities produce light and shade effects.

Cement, Lime, and Plaster

Reaction of water on calcium aluminates. LANSING S. WELLS. Bur. Stand., *Jour. Research*, **1** [6], 951–1009 (1928).—This investigation included the study of the mechanism of the reaction of water on a high alumina cement and the following anhydrous calcium aluminates: monocalcium aluminate, 3:5 calcium aluminate, 5:3 calcium aluminate, and tricalcium aluminate. Since the addition of water to tricalcium aluminate produces a very vigorous reaction, changes in the composition of the resulting aqueous solutions could not be followed in the case of this aluminate. Previous investigators have indicated that its setting is due to the formation of hydrated tricalcium aluminate. It was however possible to follow the mechanism of the reaction of the other aluminates and high alumina cement in the formation and decomposition of the metastable calcium aluminate solutions. During the early periods of the reaction a portion of the lime and alumina in each case passed into solution as the calcium salt of monobasic aluminic acid. The total concentration of this aluminate depended upon the chemical composition of the anhydrous aluminate or cement from which it was formed, as well as upon the time of the reaction. These monocalcium aluminate solutions were metastable and soon decomposed with precipitation of a portion of the lime and alumina. Identical changes in the metastable solutions took place when filtered from the reaction mixture. Part of the lime and alumina likewise precipitated from these clear metastable solutions and resulted in "equilibrium" solutions similar to those obtained when the aluminate or high alumina cement had been left in contact with the water for long periods. In both cases equilibrium apparently was reached only after several weeks had elapsed. Chemical analyses and microscopic examinations of the material precipitated from the metastable solutions indicated that hydrated alumina and hydrated tricalcium aluminate were precipitated as equilibrium was approached. To p_H of the aqueous solution in equilibrium with these two solid phases, hydrated alumina and hydrated tricalcium aluminate is approximately 11.75. Calculations based upon electrometric measurements and chemical analyses are submitted which indicate that the alumina exists in solution as the calcium salt of monobasic aluminic acid, and that the quantity of "free" calcium hydroxide in excess of this salt is the determining factor of the p_H. It has been shown that the more concentrated monocalcium aluminate solutions are metastable, since they are supersaturated with respect to the more insoluble form of aluminic acid as well as the hydrated tricalcium aluminate. An investigation has been made of the subsequent changes in the aluminate solutions attended by increasing concentrations of calcium hydroxide. Analogous changes in the aluminate solutions are affected by the calcium hydroxide liberated by the hydrolysis of tricalcium silicate in such solutions. A study of the electrometric titration of aluminum chloride with calcium hydroxide has been made. R.A.H.

Deterioration of calcined gypsum. ANON. Bur. Stand., *Tech. News Bull.*, No. **139**, p. 159 (1928).—An investigation of the factors which influence the deterioration of calcined gypsum has been in progress for some time at the Bureau. The investigation

has thus far been confined to a study of the effects of various impurities on the stability of the plasters. Seventy mixtures containing 99% calcined gypsum and 1% impurity were prepared and allowed to age in the laboratory together with similar lots without impurities. At the end of 18 months it was found that the majority of mixes contained the permissible amount of water of crystallization. In a few cases, however, notably those where chlorides, nitrates, and iodides were present, the mixtures were extremely lumpy and almost set, the moisture content varying from 2 to 3 times that which is permissible. It was found that the salts which caused deterioration were soluble and some were hygroscopic. Since all of the salts thus far found to accelerate deterioration are more soluble than gypsum it appears that a large part of the deterioration due to impurities may be eliminated by the simple expedient of washing the ground rock before calcination. R.A.H.

Anhydrite in cement retardation. ANON. *Cement, Mill, and Quarry*, **32** [12], 36 (1928).—There is a wide variation in the physical properties of anhydrite as it occurs in nature. An investigation was carried on concerning the action of anhydrite as a retarder for Portland cement and is now being carried further to ascertain whether the type of anhydrite or its degree of fineness might not have an effect upon its action as a retarder. The tests originally outlined to cover this investigation have been practically completed and it is found that the type of anhydrite has no marked relation to its action as a retarder but that the fineness of the retarder is of considerable importance. If the cement is properly retarded all forms of calcium sulphate will produce practically the same quality. E.P.R.

Uses for marble dust products. ANON. *Cement, Mill, and Quarry*, **32** [12], 63 (1928).—Marble dust, pulverized with certain dry acids, may be molded when wet with magnesium chloride, and, if mixed to the consistency of tooth-paste and trowled out on any kind of a surface, will harden in an hour and take all the original properties of marble. It takes a high polish and a slab $^5/_8$ in. thick may be swung on hinges or adapted in any way to the use of hardware. Marble broken up and segregated according to color may be treated in this way and worked up into floors exactly resembling tile, with solid colors through the mixture and at less than one-half the cost of laying tile. E.P.R.

Hungarian bauxite cement. ANON. *Cement, Mill, and Quarry*, **32** [12], 74 (1928).—The chief varieties of Hungarian bauxite available are well suited for the manufacture of fused aluminous cement. Two kinds are equally good, the bauxite from Talimba which is rich in iron and low in silica, and that from Gant which has less iron and about 8% $SiO_2 + TiO_2$. From both of these varieties an aluminous cement can be made whose melting point lies between 8 and 9 Seger cone (about 200 to 300°F) and whose strength characteristics exceed those of the best Portland cement. E.P.R.

Cement mill. ANON. *Cement, Mill, and Quarry*, **33** [1], 7–10 (1928).—The Great Lakes Portland Cement Corp.'s new plant at Buffalo is one of the largest cement plants yet built. All of the limestone received at the plant is less than 1 in. in size, and is fed to the wet mills without preliminary crushing. Shale is quarried on the company's own property about 5 miles from the plant. Limestone and shale are ground together, with water. The kiln feeders are of the Allis-Chalmers ferris-wheel type. They are driven by variable speed motors of 1.3 to 4 H.P. and 300 to 900 r.p.m., through Farrell herringbone speed reducers. The four Reeves kilns, each 11 ft. in diameter and 250 ft. long, are driven by 100-H.P. motors through Morse silent-chain drives. The clinker from them passes to four Reeves 9- by 90-ft. rotary coolers, driven by 50-H.P. motors. The hot gases from the coolers are utilized for the drying of coal. The finish grinding equipment is much the same as in the raw grinding department. The mills are 8 ft. in diameter and 30 ft. long, and are driven by 800-H.P. General Electric super-

synchronous motors. The clinker is fed to them by means of table feeders, driven by variable-speed direct-current motors of 1.3 to 4 H.P. and 300 to 900 r.p.m.

E.P.R.

Hydration of lime. ALFRED B. SEARLE. *Cement, Mill, and Quarry*, **33** [2], 11 (1928).—Hydrated lime has largely replaced lump lime in many parts of the U. S., and its use in the British Isles is rapidly extending. Yet it is not equally suitable for all purposes for which the wet-slaked lime is used. When lime is hydrated mechanically so as to form a dry powder, there is always a tendency to overheat it slightly and to produce a material which, when mixed with more water does not produce so plastic a putty as lump lime which has been made direct into putty. The result is that the paste or putty made with some hydrated limes does not spread as easily and it does not adhere as well to walls and ceilings as lime putty which is made in the old-fashioned way. This difference is due mainly to overheating. For a more detailed explanation see Ray and Mathers (*Ceram. Abs.*, **7** [9], 638 (1928)) who show that the plasticity or workability of lime putty is due to the formation of colloidal lime and that the proportion of this substance is much larger in lime putty made direct from lump lime than in putty made by hydrating the lime to a dry powder and afterwards adding more water. The results are fully in accordance with what would be anticipated from a knowledge of colloidal materials, for many colloidal gels are known which, if slightly overheated, cannot be made to recover their original state by any simple treatment. The investigations just mentioned show that the gel in lime putty is another of these "irreversible gels." This raises the whole question as to whether lime can be hydrated in such a manner as to avoid "reversing" the gel and, to ascertain this, more investigations will be required. E.P.R.

Additive materials for making Portland cements acid-resisting. ANON. *Cement, Mill, and Quarry*, **33** [2], 82 (1928).—The ordinary cement must be especially treated if it is to withstand the contact of acids, for some of the tricalcium silicate (the main cement constituent) dissolves partially on hydration to form calcium hydroxide which gradually carbonates. Both calcium sols are practically soluble in solutions of mineral or organic acids. The addition of acid-proof substances is ineffective and what is required is the addition of substances which combine with the cement to form insoluble materials. Treatment with silico-fluoride is not always practicable as the outer skin may break, giving rise to interior decomposition. At the Moscow Silicate Research Institute, experiments were carried out on the effect of the addition of water glass, sand, freshly precipitated silica gel, quartz, diatomaceous earth, silica, lead oxide, barium sulphate, asbestos, feldspar, fired clay grog, and trass. The last of these gave the most satisfactory results but could not be regarded as completely resistant since the acid-soluble constituents of the cement were still present. Four highly resistant cements were obtained from mixtures of water glass, feldspar, grog, trass, and red lead. It appears that they were not appreciably attacked by boiling sulphur dioxide solutions in laboratory tests and, after 60 hours' treatment in a cellulose boiler at 105 to 148°C, only one test piece, intentionally badly made, had lost 9% of its weight. The other three showed no appreciable change. These cements were highly resistant to acids with the exception of hydrochloric. Hot nitro-hydrochloric acid caused destruction and the cement became brittle and crumbled under slight pressure. The suitability of such cements for reinforced structure depends on their adhesion to iron and the thermal expansion of the set product. Their cost is only slightly higher than that of untreated Portland cement. E.P.R.

High alumina cements. FERET. *Le Ciment*, **33** [5], 205–207 (1928); *Rock Prod.*, **31** [23], 93 (1928).—In connection with the experiments of Berl and Loeblein, F. believes that the quality of the hydraulic cements could be further increased if they were

produced with a lowest possible content of silicic acid. A prerequisite for the production of such cements would be the use of purer bauxites. F.P.H.

New regulation standards for hydraulic binders. ANON. *Le Industrie del Cemento*, [25], 14–18 (1928); *Rock Prod.*, **31** [24], 92 (1928).—In accordance with the new Italian standards (decree of Sept. 4, 1927), cements are grouped into the following classes: (1) hydraulic lime; (2) high hydraulic lime; (3) rapid setting cement; (4) slow setting cement. The regulations contain exact directions for conducting the tests to be made, the delivery requirements, and precautions for control in the manufacture of cement. F.P.H.

Gypsum and anhydrite in the manufacture of Portland cement. I. RICHARD K. MEADE. *Rock Prod.*, **31** [24], 55–58 (1928).—The effect of various forms of calcium sulphate as retarders and the relative importance of anhydrite and gypsum as retarders are discussed. F.P.H.

Lime in cement-trass mixture. ANON. *Tonind. Ztg.*, **52** [51], 1037–38 (1928); *Rock Prod.*, **31** [23], 92–93 (1928).—Considerable lime is liberated in the hardening of Portland cement; therefore those fillers should be used for Portland cement mortar which set the lime and render it insolubly hard, *e.g.*, finely ground blast-furnace slag, silicate material, and trass, for they contain silicic acid which changes the excreted lime into lime-silicate. Although a mortar thus prepared sets slower at the start and the hardening period is much longer, the final strengths are considerably greater than in the ordinarily prepared Portland cement mortar. Less known are mortar mixtures of cement, lime, trass, and sand. A mixture of one part by weight of Portland cement, 0.5 Bayarian trass (ground to cement fineness), 0.75 of pressed lime putty, and 5 parts of standard sand was tested. The ratio of tensile strength to compressive strength never attains the value 0.10. The compressive strength is that of a good cement-sand mixture. It is striking that under a combined storage of 1 day in air and 6 days in water and then 21 days in air, the strengths were markedly less than those for under-water storage alone, being 384 lb. per sq. in. tensile and 5390.7 lb. per sq. in. compressive strength. The above cement-trass mixture, without the use of standard sand, is being used in the construction of a concrete dam. F.P.H.

Cement testing in Italy. GUILIO REVERE. *Tonind. Ztg.*, **52** [56], 1138–39 (1928); *Rock Prod.*, **31** [23], 93 (1928).—R. has determined the strengths of many samples of cement and gives the results preparatory to new cement standards. F.P.H.

Cement and lime industry in Province Alessandria, Italy. ANON. *Tonind., Ztg.*, **52** [64], 1301–1302 (1928); *Rock Prod.*, **31** [24], 92 (1928). F.P.H.

Strength formula of cement-mortars. I. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind., Japan*, **31** [11], 276B (1928).—The increasing rate of strength of cement mortar to curing ages was already the subject of study on cementing materials in 1886 (W. C. Unwin, *Chem. and Ind.*, **5**, 188 (1886)). The author studied first Unwin's rational formula $y = a + b(x - 1)^n$ (*Ibid.*, **8**, 430 (1889); **29**, 458 (1910)) in which a is the strength at one week, y is the strength at x weeks, b is a constant of cement, and n is $^1/_2$, $^1/_3$, etc. By applying many results of strength tests of 1:3 mortars of Japanese and foreign cements at every curing age (1, 2, 3, 4, 8, 13, and 26 weeks), the value $b = \dfrac{y - a}{(x - 1)^n}$ was observed to be never constant as in the following:

(1) Values of $b = \left[\dfrac{y - a}{(x - 1)^n}\right]$ in tensile strength

		n:1/3						n:1/2					
No. of cement		2w.	3w.	4w.	8w.	13w.	26w.	2w.	3w.	4w.	8w.	13w.	26w.
Low silica type	1	0.30	0.47	0.55	2.25	2.98	2.84	0.30	0.42	0.46	1.63	1.96	1.94
	2	1.00	2.38	3.74	3.45	3.19	2.94	1.00	2.12	2.54	2.49	2.10	1.72

High silica type	5	2.10	2.78	3.19	3.66	3.50	3.11	2.30	2.48	2.60	2.49	2.31	2.12
	6	2.70	3.97	4.58	4.18	4.28	4.34	2.70	3.54	3.72	3.02	2.83	2.62

(2) Values of $b = \left[\frac{y-a}{(x-1)^n}\right]$ in compressive strength

		n:1/2						n:1/2					
No. of cement		2w.	3w.	4w.	8w.	13w.	26w.	2w.	3w.	4w.	8w.	13w.	26w.
Low silica type	1	47.0	61.1	66.6	83.7	90.0	78.7	47.0	54.5	55.4	60.5	60.0	46.0
	2	67.0	88.9	100.6	99.4	91.3	74.9	67.0	79.2	82.6	71.8	60.3	43.6
High silica type	5	47.0	62.7	66.6	94.1	100.9	89.6	47.0	70.0	72.7	68.0	66.7	52.4
	6	67.0	93.7	106.1	107.2	104.9	113.2	67.0	83.4	88.3	77.5	69.3	60.8

Thus Unwin's rational formula can never be applicable to the early-high-strength Portland cements; the relation of strengths and many curing ages (2, 3, 5, 7, 14, 21, 28, 56, 91, and 182 days) were studied by graphical and calculation methods. The reasonable strength formula was obtained, the discussions and studies of which will be reported in the second paper. E.J.V.

Gypsum production in 1927. ANON. *Eng. Min. Jour.*, **126** [5], 180 (1928).—The gypsum industry in the U. S. in 1927 produced 5,346,888 T., a decrease of 288,553 T., or 5% compared with 1926. The production for 1927 has been exceeded only in 1925 and 1926. The total value of the gypsum sold or used in 1927 was $42,174,454, a decrease of $4,546,765, or 10% compared with 1926. New York produced nearly 1/3 of the quantity produced in the entire country. The other states in order were Iowa, Mich., Texas, Ohio, Nev., and Okla. A.J.M.

Use of anhydrite in cement retardation. ANON. *Eng. Min. Jour.*, **126** [6], 214 (1928).—The following conclusions are drawn: (1) clinker and retarder should be ground together; (2) the type of anhydrite has no marked relation to its action as a retarder, but the fineness is important, particularly in its effect upon the plasticity of the cement; (3) although cement of good quality has been obtained by using anhydrite as a retarder, the variation in the properties of the cement clinker itself makes it essential that information be obtained concerning the retarding action of calcium sulphate before definitely stating which form, if any, is the most efficient retarder for Portland cement clinker. A.J.M.

Unusual features of a lime plant. H. D. KEISER. *Eng. Min. Jour.*, **126** [8], 298–99 (1928).—The plant described is the Chief Consolidated Mining Co., Eureka, Utah. The kilns are unusual, being formed by rising through the limestone composing the quarry floor, the tops of the kilns being at the same elevation as the floor. Circular in shape and spaced 21 ft. apart on centers, both kilns are 65 ft. high, 12 ft. in diameter at the bottom, 15 ft. at the top, and 18 ft. at half their height. Each is equipped with a steel hopper at the bottom, which supports a grate consisting of railroad iron spaced 5 in. on centers. Although the kilns have operated steadily since they were constructed two years ago, slacking-off of the walls has been negligible, and no repairs of any kind have been necessary. A mixed feed of limestone and 13% of pea-sized coke is charged to the kilns. The capacity of the kilns is 100 T. of burned lime in 24 hours. Two blowers are used to furnish the forced draft necessary when this output is desired. A narrow-gage track runs from underneath the kilns to the loading chute outside. On reaching the hydrating plant the burned lump lime is first ground in a No. 1 1/2 Sturtevant rotary crusher, and then treated in a Clyde batch hydrator, after which it is cooled and pulverized in a Raymond centrifugal mill. The capacity of the hydrating plant is 40 T. in 24 hours. A.J.M.

Overproduction adversely affects gypsum industry. ANON. *Eng. Min. Jour.*, **126** [13], 496 (1928).—A smaller demand for gypsum products in building materials in 1927 was accompanied by record domestic production. The result has been a decline

in prices and excessive competition. The earnings of many gypsum companies have been appreciably reduced. An important development in gypsum technology is the introduction of a special gypsum board which is replacing wood lath in house construction. A light-weight gypsum flake of large bulk has also been introduced for use as an insulator in house construction. A gypsum sheathing to replace wood sheathing and building paper is another recent development. A continuation of the investigation into the suitability of gypsum anhydrite mixtures as retarders in Portland cement has shown excellent results. A.J.M.

Crazing and the growth of hair cracks in concrete. ALFRED H. WHITE, WILHELM A. AAGAARD, AND AXEL O. L. CHRISTENSEN. *Eng. News-Rec.*, **100** [12], 481–82 (1928).—Crazing is due mainly to the rapid evaporation of water from surface of a rich cement mortar or concrete. The surface dries and is restrained from contracting by wet interior body. Portland cement after hydration is a mixture of crystalline and colloidal material and the latter expands when wet and contracts when dry. The same forces causing hair cracks also cause enlargements of such. Development of cracks is greatest in rich mixtures. A troweled surface being richer in cement is more likely to crack. Crazing may be prevented by use of lean mixtures and by keeping moisture content of the concrete constant. Integral waterproofings of the water-repellent type are also helpful. L.A.P.

Heat balance in rotary cement kilns. H. POOLEY, JR. *Engineering*, **126**, 219–20 (1928).—In the average rotary cement kiln, 200 ft. long and 9 ft. internal diameter, giving an output of 1100 T. of clinker per week from a slurry containing 38% moisture and a coal of 12,600 B.t.u./lb., the coal consumption is about 28% of the clinker produced and the temperature of the flue gases about 420 to 430° and of the clinker discharge about 310 to 320°. The heat introduced to such a furnace is distributed as follows: from the coal 92%, from the exothermic reaction 4.75%, and from the sensible heat of the constituents of the charge 3.25%. The heat expended is utilized as follows: in evaporating slurry water and superheating 40%, in decomposing carbonates 24.5%, in flue gases 20%, in clinker discharge 3%, and in radiation 9%, leaving 3.5% unaccounted for. A slight excess of air over the theoretical is necessary for economical working; too large an excess or a deficiency of air leads to a higher coal consumption. Accurate control of the kiln is obtained by installing recording pyrometers in the flues and clinker-discharge outlet, and by frequent analysis of the flue gases, which should contain 1 to 2% oxygen. (*B.C.A.*)

Enamels

Report of Enamel Standards Committee, 1927–1928. E. P. POSTE, J. E. HANSEN, W. N. HARRISON, AND B. A. RICE. *Bull. Amer. Ceram. Soc.*, **7** [12], 347–67 (1928).—Rather than originate tests, the Committee has taken the position that its function is to study tests that come to its attention. A technologic paper by the Bureau of Standards on "Controlling the Consistency of Enamel Slips" was published, a paper on the general subject of opacity is on the present program, and the attention of purchasers is called to the difference in the use of fineness figures by producers of raw materials. In *Appendix A* are reported the results of a control tests questionnaire sent out in 1926–27, and some new tests suggested are described. In *Appendix B* are presented notes on the sieve and settling tests for fineness of enamel. Notes on a tentative method for the determination of the deformation temperature of enamel are given in *Appendix C*. Pick-up and specific gravity tests for enamel slips are discussed in *Appendix D*. Detailed drawings of and further studies of the Lindeman-Danielson cross-bending machine are given in *Appendix E*. *Appendix F* contains a report of methods of expressing enamel formulas, with the consensus of opinion to express the enamel formula in terms

of raw batch weight in such a size batch that the melted composition will make 100 parts. E.J.V.

Control raw material processing to avoid defects in enamelware. CARL W. MEHLING. *Ceram. Ind.*, **11** [6], 572–76 (1928).—M. describes the methods and equipment used in the enameling plant of the American Radiator Co. and emphasizes the control methods used. The following subjects are discussed: (1) improving enamel uniformity, (2) regulation of mill time, (3) controlling fineness of enamel, (4) a simple fineness test, (5) testing strength of pickling acid, (6) bending test for enamels, (7) colored enamels. F.P.H.

Method for reclaiming enamelware. ANON. *Ceram. Ind.*, **11** [6], 576 (1928).—A new successful method for reclaiming enamelware, such as sinks and bath tubs has been developed. The first operation consists of using the finest of silicon-carbide wheels and water, and smoothing out the imperfection; after this a dust, consisting of 75% enameling powder and 25% tin oxide is applied, and special buffing wheels of various textures and sewed in a certain way are applied to the ware. In this way the defects are overcome to such an extent that only the keenest observer can locate them on a piece of ware. F.P.H.

Preventing defects in enamelware. F. J. WATSON. *Ceram. Ind.*, **11** [6], 577–83 (1928).—Gas pockets in sheet steel are the cause of blisters in enamelware. These blisters frequently reveal themselves during the pickling operation, but if a piece of steel is free from such blisters and is properly cleaned, it is only a remote possibility that any defects in the enamel coating can be properly attributed to bad steel. The wares should be carefully placed in the pickling tank to prevent air pockets and to avoid contact of flat surfaces. A lead pipe introduced into the tank, laid on the bottom and coming up at the opposite side, forming a drip for the condensed steam so as not to change the strength of the acid is beneficial. Tearing is also the result of fracturing the enamel before firing. Careless handling of sheets during the brushing process loosens the film sufficiently to cause crawling. The tables should be arranged so that there is no chance to bend the piece. Taking for granted the truth of the statement that tearing is caused by fracturing of the enamel film, it is obvious that anything that will strengthen the film will tend to reduce tearing and conversely anything that will weaken the film will tend to increase tearing; therefore sign enamelers are familiar with the practice of adding gum arabic or gum tragacanth to the enamel slip to prevent tearing. New wet clay will cause tearing because of lost weight of actual clay through the water inclusion. It is safest to dry the clay by leaving it exposed to the air. Overfiring of the ground coat can easily be recognized by the fact that enamel has a more or less brownish green transparent finish, rather than a healthy blue color or a bluish black appearance depending on the type of ground coat that is being used. Underfiring may be caused by too low a firing temperature or by the enamel having been applied too heavily and this underfired condition will lead to blistering of the ground coat through the cover coat or it may fishscale before the cover coat is applied. Copperheads, red-brown spots which appear on the sheet ground coat enamel when fired, are caused by faulty pickling in which case the enamel cannot properly cover the ware but breaks away in these small spots. Copperheads also appear on ground coat which is applied too thick even though the metal is perfectly clean and in such a case the enamel coating does not have enough body to properly cover the metal and any spots of metal which are directly exposed to the heat become oxidized and form copperheads. In enamel which is badly overfired there is considerable tendency for copperheads to form. F.P.H.

Uniformity of processes prevents enamelware defects. F. M. BURT. *Ceram. Ind.*, **11** [6], 586–89 (1928).—The old practice of using large flux blocks in the smelter pot

has practically disappeared, because of the difficulty of securing the proper size and composition of blocks on short notice, and because the grade of standard straight brick designed expressly for smelter use, will give much better results than the older practice. In addition to increasing the smelter life, a lining from brick of a special composition is more economical in first cost than the more common, formerly used blocks. The curb wall should also be of brick of special manufacture for resisting the corrosive action of the charge. It might be advisable to state in this connection that extreme care should be exercised in selecting materials for pot construction, and in no case should an unknown brick be used in lining the smelter pot due to its being easily available at times of rushed production. Such practice has resulted in a discolored or otherwise inferior frit which could not be used. The most frequent causes of defects which show up in the final product are: (1) contamination of enamels by foreign substances in unloading, handling, smelter linings, stirring rods, poor combustion, clay plugs, etc.; (2) lack of uniformity in mixing, over- or under-smelting, which is caused by improper temperature control, and batches too large or small for the size of smelter; (3) lack of uniformity in chemicals applied, and inferior chemicals; (4) lack of knowledge of the subject at hand, *i.e.*, control of enamels. F.P.H.

Effect of raw materials on defects in colored enamelware. H. G. WOLFRAM. *Ceram. Ind.*, **11** [6], 590 (1928).—Due to the large demand for colored enamelware, this industry has experienced a new trouble. Defects occur which have either been unknown to the enamel man previous to this new era or which have appeared but have been neglected because of the small amount of colored ware manufactured. In some types of colored oxide, a lead base frit is necessary to produce the brilliant shades required. With other types of oxide, lead is very detrimental to the results obtained. The manufacturer of colors has much to consider when compounding an oxide. These include (1) proper weights of raw materials which go to make up the oxide, (2) calcining or firing conditions under which these materials are brought to a stable condition, (3) grinding of the material after calcination, (4) washing of the material and drying. It is not possible to make oxides in as large amounts as enamel frit, *e.g.*, in 1000-lb. batches; but numerous small batches must be made up and thoroughly mixed to produce one shade. A mottled effect is sometimes produced by the use of unstable chromates which will not stand up under the temperature or disintegrating effect of the enamel. A scumming or dulling of the surface of the enameled ware may be due to the fact that the entire amount of soluble salt has not been thoroughly removed from the oxide. Brilliancy is greatly affected by the enamel frit composition. For instance, brilliant green colorant in enamels should be used in enamel free from zinc, as the zinc content will affect the brilliancy of the color. Also chrome tint pink colors should be used in zinc-free enamel in order to produce the full brilliancy of the color. F.P.H.

New ceramic floatative. ANON. *Ceram. Ind.*, **11** [6], 608 (1928).—A new material called ammonium algernate is made by treating seaweed with ammonia resulting in a green paste, which has a very offensive odor, and has been found to be a good floatative for enamels. When using this material, a close watch must be kept on the water content, and the enamel must be milled for a little time before the algernate is added. To obtain the best results, it is best to mill the enamel as fine as permissible.

F.P.H.

Vitreous enameling in the electric furnace. ANON. *Proc. Nat. Elect. Light Assn.*, **84**, 416–19 (1927).—The many advantages of the electric resistance type heating furnace over several other types are discussed. Installation data are also given. Electric heat's advantages are: (1) even temperature; (2) easy heat control; (3) more uniform product; (4) human element in production reduced; (5) reduction in fire hazard; (6) cleanliness; (7) less restriction in location; (8) better working conditions; (9) re-

duced labor turnover; (10) less time out for repairs; (11) favorable cost of finished product. Installation data are furnished on plants operating 90, 110, 180, and 840 kw. electric furnaces for firing ware. Comparison with other types of furnaces shows the electric furnace to advantage. Although on a B.t.u. basis, electricity is more expensive than the usual fuels, its economy is obtained in the conservation of heat. The electric resistance type heating unit gives off heat without combustion, reducing the amount of ventilation of heat to an absolute minimum. In many cases, even though the cost of the current for the electric furnace is more than the cost of fuel for other kinds of ovens, the better quality, the reduced rejects, the reduced handling costs due to location of the furnace, the reduced labor costs, the reduced time out for repairs all combine to make quite an attractive saving in favor of electricity. It has been noted time and again that the more carefully the operating conditions of the vitreous enameling plant have been analyzed as a whole, the better is the field for the electric furnace. R.G.E.

Use and interpretation of transverse test for cast iron. J. C. PEARCE. *Foundry Trade Jour.*, **39** [632], 219–22 (1928).—Explains fallacy in derivation of formula for breaking load. The specific resisting stress set up in the beam is not the same for the cast as for the specified diameters. Curves describe variations of modulus of rupture as diameters of cast bars are varied. The specific strength of a cast bar diminishes as the diameter of the bar increases. Where the bending strength follows the curves as given, no simple conversion can apply the modulus for one diameter in calculating that for another diameter. The round bar is stronger than the square bar even when the former is prepared from a bar originally cast square; and a square bar prepared from a bar originally cast round is weaker than a round bar. Interesting relationships between compositions and strengths are cited. The strength of standard bars should be compared with similar sections cut from actual castings. L.A.P.

Oxygen and metals. F. JOHNSON. *Foundry Trade Jour.*, **39** [635], 279–80 (1928).—A theoretical discussion of various forms and phases of oxidation. J. gives no data but cites several interesting and not well-known facts concerning oxidation in the melting of metals, oxide surfaces, deoxidation, etc. L.A.P.

Effect of various elements on malleable cast iron. L. E. GILMORE. *Foundry Trade Jour.*, **39** [635], 283 (1928).—Effects of various elements in their combinations and reactions with one another are discussed. Available information and general views of the more important effects of various constituents on malleable cast iron are given. L.A.P.

Heat treatment and volume changes of gray cast irons from 15 to 600°C. I. J. W. DONALDSON. *Foundry Trade Jour.*, **39** [636], 299–302 (1928).—With a total carbon content ranging from 3.1 to 3.3% little change takes place in heat-resisting properties of cast iron. With further increase in carbon there is tendency toward increased decomposition, while with decrease of C there is marked increase in stability. The stability of Fe at any temperature is increased by increasing Mn content. The stabilizing effect of phosphorus is due to fact that the eutectic of Fe, C, and P is more stable than the eutectoid of Fe and C. Si has a very noticeable effect of heat-resisting properties of cast iron. **II.** *Ibid.*, **39** [637], 315–18 (1928).—Gray cast irons subjected to repeated heatings and coolings at temperatures below their critical range invariably show volume changes of varying magnitudes. The increase in volume following the first few heatings is due to the decomposition of the combined carbon, if increase in size of graphite flakes accompanies such decomposition. If graphite flakes increase, however, air penetrates and causes oxidation of Fe near graphite, which oxide gradually replaces the graphite, and this causes further volume changes. The extent of growth depends first on dimensions and form of graphite after decomposition of the combined C and second on relative amount of oxidation, determined by composition of Fe. In-

crease in Mn content causes slight increase in graphite growth, due to rapid oxidation of Mn of the decomposed carbide. Increase in P hinders volume changes, the phosphide eutectic decomposing more slowly than the pure Fe-C eutectoid. Irons containing up to 1.1% of Si show little growth, while if the Si ranges from 1.2 to 1.5%, there is a fair volume increase accompanied by oxidation of the Fe (ferrite) which increases, but a maximum is attained after 100 hours at 550°C. With 1.5 to 2.2% Si, there is marked growth due to oxidation of the Si and Fe (silico-ferrite) which continues after 200 hours' heating, the extent and rate of growth depending on the Si content. L.A.P.

Cone softening point method for determining relative fluidity of enamel frits. D. DEURVORST. *Sprechsaal*, **61** [29], 561–64 (1928).—Twelve normal enamels for sheet iron are itemized and the melting periods given, using 1250°C as an approximate constant working purification temperature. The time of deformation of the series of 12 cones of frits with an approximate constant rate of heating is also included which gives the temperature at which deformation started and complete fusion of the cones. The calculated time for reaching fusion is compared with actually obtained temperatures in this study. The values are also compared with calculated values using the so-called "refractory factors" obtained by Staley (*Ceramist*, **8** [1], 1926). R.A.H.

Danger to health of antimonial enamels. B. REWALD. *Z. angew. Chem.*, **41**, 287–88 (1928).—A criticism of the conclusions of Flury (*C. A.*, **22**, 1622). Stress is laid on the innocuous character of Na metantimonate and compounds of quinquevalent Sb generally. In a rejoinder Flurry points out that compounds of quinquevalent Sb may be reduced in the actual process of manufacture of the enamel, and that enamels made from such compounds have in fact been shown to yield salts of tervalent Sb, when subjected to acid solutions. (*C.A.*)

BOOK

Enamels: Manufacture and Application to Iron and Steel Ware. L. R. MERNAGH. C. Griffin & Co., Ltd., London, 1928. Price 18 *s.* H.H.S.

PATENTS

Enameling furnace. RANDAL E. TALLEY. U. S. 1,692,060, Nov. 20, 1928. In an enameling furnace the combination with a permanent rack for supporting articles, of bars for capping portions of the permanent rack, the bars being removably attached to the rack and being further disposed to constitute supports for removable rack members which are adapted to be charged into the furnace.

Enamel-coated article. JOHN A. ANDERSON. U. S. 1,693,130, Nov. 27, 1928. A heat-resistant object comprises a base coated with enamel whose components include 60% silica and an anchoring material.

Clouding enamels, etc. I. KREIDL. Brit. 297,724, Nov. 21, 1928. Enamels are adapted to be clouded by the production in the mass of finely distributed bubbles of gas evolved during the firing of the enamel by substances which are added to the batch in the enamel mill. Organic clouding materials such as formic acid and its salts, acetic acid and its salts, naphthol, benzidine, starch, and flour may be employed. Inorganic-organic substances, may also be used, the organic portion being the effective gaseous clouding medium. Gas may be evolved by the chemical interaction of two or more substances, for example carbon and an oxidizing agent. An oxidizing agent such as saltpeter may be added to the clouding medium or the enamel batch to prevent discoloration due to carbon or its compounds. Carbides are also mentioned as clouding substances. The invention is also stated to be applicable to the clouding of glass.

Clouding enamels, etc. I. KREIDL. Brit. 297,725, Nov. 21, 1928. Enamels are clouded by the production in the mass of finely distributed bubbles of gas evolved during the firing of the enamel from inorganic substances or compounds which are

added to the batch in the enamel mill. The substance may be adapted to liberate gases during the firing of the enamel by chemical interaction with one or more other substances. The insoluble residue which remains after evolution of gas is so small as to have no clouding effect. The substance may be soluble in water or it may be of colloidal form. Examples given are metals, metalloids, and their compounds. The invention is also stated to be applicable to the clouding of glass.

Enamels; glass. I. KREIDL. Brit. 297,737, Nov. 21, 1928. Enamels and glasses are clouded by adding to the batch small quantities of compounds which volatilize during the melting and cause the distribution of fine bubbles of gas or vapor within the molten mass. The materials used are organic compounds of tin, titanium, zirconium, or antimony, and only such small quantities are used that the residue left after volatilization is insufficient to cause clouding on its own account.

Glass

Faulty molds cause defects in pressed glassware. ROY E. SWAIN. *Ceram. Ind.*, **11** [6], 595–97 (1928).—A brief history explaining the process of pressing is given and some of the limitations and possibilities of this system of glass working are pointed out. F.P.H.

Glass edging machine. ANON. *Ceram. Ind.*, **11** [6], 597 (1928).—This machine was developed to provide an easy mechanical means of edging panels or glass, being especially adapted for edging of glass sheets. A mechanical traveling frame is provided by which the plate of glass may be automatically sent through the machine at a uniform rate of speed, and a uniform pressure is applied all along the edge. In this way the edge will be true and even throughout its entire length. The machine, because of its automatic control will grind the glass accurately to a given size. The edging elements are interchangeable so that the edge may be roughed, smoothed, and polished with a single machine, or a separate machine of a similar character may be used for each operation, the only difference being in the edging element. The machine may be arranged to edge either straight or curved-edge glass, *e.g.*, the lower edge of a windshield of an automobile, etc. The machine when adapted for curved-edge work must be set by hand. It operates on the entire length of the edge at the same time, and two or more sheets may be worked at once when necessary. When the glass is set by hand, the rack in which the glass is fastened is level, and the glass edge will be exactly square when finished. When working safety glass, it will not cause either sheet to slip or separate, and if the edges are not square when edging is started, they will be when the operation is complete. F.P.H.

Control of processes eliminates defects in glassware. RALPH HARRIS. *Ceram. Ind.*, **11** [6], 598–604 (1928).—It can be said in general that glassware of uniformly satisfactory quality can be produced at a profit only by means of as complete technical control of all materials and processes as is possible to provide. It is potentially possible for sand, being the chief material of the batch, to introduce the greatest quality of impurities into it and therefore the greatest care must be taken to insure its uniform quality. Purchase contracts should specify a content of 98 to 99% SiO_2. The principal impurities in sand are titanium oxide, iron oxide, magnetic iron, aluminum oxide, calcium carbonate, dolomite, feldspars, and other combinations of silicates, clays, and organic matter. The effect or feldspar upon the working nature of the glass is very similar to that of lime, although the addition of feldspar to a lime-soda glass increases the viscosity range without in any way lowering the resistance of the glass to acids, alkalis, and weathering. Glass containing feldspar is wonderfully well adapted to pressed operations, as the skin of the glass sets quickly, thus tending to withhold from

the ware some of the slight imperfections of the molds and plungers; care must be taken, however, to enter the plunger into the molten glass as quickly as possible after the mold is charged to avoid "washboards" or settling rings in the surface of the glass through the lower portion of the side walls, and also that the metal may still be at a sufficiently high temperature to permit the completion of the operation and assure accurate pressing of the finish without strain. In working glass of comparatively high feldspar, the mold equipment should be carried at a slightly higher temperature, especially the rings and plungers, to avoid strains and crizzles in the finish. In the manufacture of colorless glasses, iron is the ever present enemy and its sources are almost as numerous as the number of materials in the batch. Other impurities are also present in most of the raw materials, some of which are of themselves harmless, but others of which are capable of causing defects and additional loss of production through the creation of improper working conditions. It is therefore essential that the purity and composition of all raw materials be under constant control by means of tests for physical characteristics and chemical analyses. Boric acid and borax improve the thermal endurance of glass by increasing its toughness and lowering the coefficient of expansion as well as aid its resistance to acids, alkalis, and weathering. In addition to this, the brilliancy is increased, adding greatly to the appearance of the finished ware. The greatest benefit to be derived from its use in the production of machine ware, and the one consideration upon which a cost higher than that of soda can be justified, is the greatly increased rate of melting and fining, due undoubtedly to a more rapid rate of elimination of seeds. By beginning with but 10 lbs. of borax per T. of sand and increasing gradually, balancing the soda for the purpose of increasing the brilliancy, improved working qualities were noticed. F.P.H.

Development of sheet and plate glass. ANON. *Glass Ind.*, **9** [12], 267–68 (1928).—The development of sheet and plate glass has made much progress in the last few years in both Europe and the U. S. The times of hand-made window glass are passed, and now the cylinder machine process has also become definitely unprofitable because the labor cost due to casting, drawing, and flattening is greater than in other processes of sheet glass drawing. There is further a considerable cost due to handling. The two methods which have made their way at present are the Colburn process in the U. S., which is used exclusively by the Libby-Owens Sheet Glass Co., and in Europe the Fourcault process, the patent rights of which have now lapsed. In both processes the quality of the glass has greatly improved so that at present the direct drawn sheet glass is extensively replacing plate glass for windows of railway cars, motor cars, and show windows. Efforts are made to economize in the manufacture of plate glass. There is more and more melting in tanks as against melting in pots. Further progress has also been made in the continuous rolling and grinding of the glass. It is important to make the rough plate glass at the very beginning as thin and as uniform in thickness as possible so that the labor of grinding is diminished. For large plates, wider than 6 ft., the old process of rolling which gives a thickness of $^3/_8$ to $^1/_4$ in. is however, the only economical one even today. For smaller widths, thicker glass, and smaller masses new processes have been developed, and three fundamentally different ones are (1) Bicheroux process; (2) glass continuously melted in the tank and poured in individual plates into the rolling machine (as in the Bicheroux process) and taken from the tank by hand by means of ladles (as in the Lubbers process); (3) process of the Ford Motor Co. In the U. S., Fourcault glass has been used only for window glass. In the early stages, it was necessary to make the glass composition very soft, but in the last few years in Belgium and in Bohemia, harder glass compositions for the Fourcault process are being used which give almost as good polishing properties as plate glass. In Bohemia the arrangement of the drawing machines differ considerably from the Belgian

methods. The Bohemian arrangement and tank form gives higher output and a better glass with smaller tanks and decreases manipulation to a minimum. The outstanding feature of this improved process is that the temperature adjustment is done from a central point for all machines, while for the production of glass thickness only the drawing speed is changed. The electrical control of the machine is very effective. The danger of devitrification is almost completely eliminated because a reheating of the glass in the drawing chamber is no longer necessary. The further development of the Fourcault process has thereby reached a certain final point. E.J.V.

Red lead for the glassmaker. R. L. HALLOWS. *Glass Ind.*, 9 [12], 269–71 (1928).—The product formed from the roasting of white lead is known today as "orange mineral" and is chemically identical with red lead. Physically, however, it differs in that it is amorphous in character. The outstanding characteristic of red lead for glassmaking is that it must be much freer from impurities than that used for other purposes. But very small traces of iron, copper and silver can be tolerated in making the finer grades of flint glass. A specially refined pig lead is used and a special refining is designed to remove all possible traces of copper, silver, and iron. The product is kept free from impurities as it is processed into red lead. The first step in preparing a red lead from the metal is the formation of litharge. The litharge used in making glassmakers' red led is made usually either by oxidizing the lead in a reverberatory furnace by rabbling at about 1200°F or by oxidizing at a much higher temperature. In the latter case the molten metal is subjected to a blast of air on its surface which oxidizes it at the point of contact with the air and blows the resulting molten oxide or litharge away. This issues continuously from the furnace and is either collected as molten litharge in pots or allowed to fall on to a plate which causes immediate solidification. After the litharge in the pots has cooled and solidified it is dumped onto the floor in the form of a solid cake. After a period of time it begins to expoliate and continues until it has become a mass of flakes. The "flake litharge" is a red product, while the litharge which solidifies on the plate is yellow. Thus, litharge is an allotrope and may occur in either the red or yellow form depending upon whether the molten product is cooled quickly or slowly (quickly cooled litharge is yellow, whereas a slowly cooled material is a buff color). Glassmakers' red lead is made by milling the litharge and then burning it into red lead by subjecting it to an oxidizing atmosphere at a temperature below that used for making litharge (1200°F) and allowing the charge to oxidize to the desired stage. Usually the glassmaker specifies that his red lead contains 60 to 75% true red lead, or Pb_3O_4, and the remainder residual litharge (PbO). After the red lead has been removed from the furnace it is milled or screened and then packed in barrels for shipment. The red lead used for glassmaking does not have to be ground exceedingly fine because its physical identity is soon lost when it is placed in the glass furnace and, too, a coarser product makes less dust. Either red lead or litharge may be used to introduce lead into glass. The glassmaker is chiefly concerned with the determination of the moisture, red lead or Pb_3O_4, copper, iron, metallic lead, and silver content of red lead and methods are given for determining these constituents with the exception of silver. Silver is determined by the standard fire assay and can be found in any of the test books on assaying. E.J.V.

Building new works for Bicheroux process. ANON. *Glass Ind.*, 9 [12], 275 (1928).—Plans, officially confirmed, were disclosed for the construction by the Edward Ford Plate Glass Co., of Rossford, Ohio, of a continuous grinding and polishing plant equipped for operation by the Bicheroux process and involving an investment of more than $3,000,000. More than $750,000 have been invested at Rossford in the installation of the new casting process with its special leer. It means that the capacity of this company will eventually be doubled. Six million square feet of thin plate glass such

as used by the automotive and building trades and for making laminated glass will be added to the present output of 14,000,000 sq. ft. of rough plate glass. To house the equipment and provide adequate production and shipping facilities the company will soon begin the construction of a new factory unit 140 ft. wide by 1100 ft. long, with a wing 250 by 300 ft. The new grinding and polishing departments will have a capacity of approximately 15,000,000 sq. ft. annually in addition to the capacity of the present plant. Additional Bicheroux casting units may be added later to balance the production of rough plate with the finishing capacity of the new unit. This would give a total capacity of between 28,000,000 and 30,000,000 sq. ft. of polished plate glass annually. The new grinding and polishing process is a combination development of the method used by Pilkington Brothers, Ltd., largest plate glass makers of England, and Ateliers of Auvelais, Belgium, an engineering firm headed by Charles Heuze, one of the most prominent glass machinery builders in Europe. E.J.V.

New large telescope. ANON. *Glass Ind.*, 9 [12], 283 (1928).—The giant telescope which has been made possible by an appropriation from the International Education Board to the California Institute of Technology at Pasadena will have a 200-inch fused quartz reflector, twice the diameter and four times the area of the Mt. Wilson 100-inch glass reflector, at present the largest in the world. It will be located on some mountain top near Mt. Wilson, and will coöperate with that observatory. The mirror will be made at the Thomson research laboratory of the General Electric Co., at Lynn, Mass. According to Elihu Thomson it is planned to cast the base, which will be about 30 in. in thickness, of sand or opaque quartz, with the top surface concaved to the approximate curve required for the mirror. This surface will then be covered with a facing of clear or transparent quartz, making it ready for the final grinding and polishing which will probably be done by optical experts at Pasadena. E.J.V.

New corporation begins glass sand production. ANON. *Glass Ind.*, 9 [12], 283 (1928).—The Eastern Silica and Chemical Co., of Winchester, Va., is producing a glass sand with the following analysis: SiO_2 99.810%, Al_2O_3 0.112%, Fe_2O_3 0.014%, CaO 0.010%, loss on ignition 0.006%, MgO 0.004%. Some prominent glass factories using sand from this deposit have stated that it fuses with 15° less heat than silica from other deposits. A report on the property states that the rock suitable for glass sand purposes is a bed or layer 200 to 300 ft. thick forming the western half of the high knob of the mountain on which it occurs. The unwashed rock is said to be very clean. Grains are very large and the final screening of the dry pans only separates out a very small amount of grit, claimed by former employees of the plant not to exceed one bushel of grit to one carload of sand. A thorough survey of the property resulted in the conservative estimate that the deposit on the property owned by the company contains approximately 7,000,000 short tons of rock suitable for silica purposes. At a production rate of 300 T. a day for 300 days a year 90,000 T. would be utilized annually. On the basis of losses of an additional 10,000 T. annually the deposit is expected to last for at least 70 years before being exhausted. E.J.V.

Fluorspar. ANON. *Glass Ind.*, 9 [12], 289 (1928).—There are three grades of fluorspar: metallurgical, ceramic, and acid. While considerable quantities are consumed in the manufacture of opal glass and enamels, by far the largest part of the fluorspar production is used in steelmaking and foundries. It is also used in the manufacture of aluminum and as a raw material in the manufacture of hydrofluoric acid. For glass manufacture ground fluoride 95 to 98% with a maximum of $2^1/_2$% silica is widely used. E.J.V.

Glassmaking in Britain. W. E. S. TURNER. *Pottery Gaz.*, 53 [618], 1930–32 (1928).—A concise historical sketch of the glassmaking industry in Great Britain, as broadcast during the First National Glass Convention. E.J.V.

Glassmaking opportunities in the southwest. JULIAN CAPERS, JR. *Glass Ind.*, 9 [12], 284 (1928).—A collection of industrial and economic information concerning the southwest contains certain facts of considerable interest to the glass industry. Engineers examined 9 separate deposits of sand suitable for making glass bottles and jars and found several points in Texas, varying in distance from 256 miles to an easy trucking distance just outside the city limits of Dallas. There are also large deposits of good glass sand in Ark. Analysis of the 9 deposits shows the following content:

	Deposits Analyzed								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Silica	99.53	99.29	98.63	98.68	99.21	99.40	98.10	90.36	96.20
Iron oxide	0.18	0.51	0.19	0.54	0.31	0.16	0.24	4.04	2.50
Aluminum oxide	0.09		0.61	0.58	0.01	0.18	1.10	4.04	
Calcium carbonate			0.21	tr	0.18			2.30	
Magnesium carbonate			0.06	tr	0.29				
Equiv. to meteoric iron			0.13	0.04	0.22				
Alkalis	0.07								
Calcium oxide						0.11			
Magnesium oxide						0.01			
Loss on ignition		0.19	0.30	0.20		0.25	0.64	2.48	0.48

Locations of deposits are (1) Santa Anna, Texas, 195 miles from Dallas; (2) Ranger, Texas, 127 miles from Dallas; (3) Marshall, Texas, 151 miles from Dallas; (4) Marshall, Texas; (5) Natchitoches, La., 256 miles from Dallas; (6) Gatesville, Texas, 140 miles from Dallas; (8) and (9) just outside Dallas. E.J.V.

Heat balance of a glass tank furnace. R. D. PIKE AND G. H. WEST. *Pottery Gaz.*, **53** [618], 1952 (1928); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [10], 734–44 (1928); see also *Ceram. Abs.*, **7** [11], 747 (1928). E.J.V.

Beryllium glass. CHI FANG LAI AND ALEXANDER SILVERMAN. *Pottery Gaz.*, **53** [618], 1953 (1928); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [7], 535–41 (1928); see also *Ceram. Abs.*, **7** [8], 520 (1928). E.J.V.

Glass manufacture. S. MIALL. *Chem. and Ind.*, **47**, 1178 (1928).—Glass manufacture was the first industrial enterprise attempted in the U. S. The war gave renewed stimulus to the industry, both in England and the U. S., and in all branches of the craft both nations are holding their own. H.H.S.

Measuring temperatures in the glass industry. H. MIETHING. *Sprechsaal*, **61**, [27], 526–28; [28], 546–48 (1928).—The necessity and advantages of keeping a close and accurate record of temperatures in glass melting tanks are stressed. The use of the thermocouple in tanks has a decided disadvantage. The ardometer, a radiation pyrometer, is especially adapted for recording continuous temperatures for long periods; the optical pyrometer is suitable for intermittent temperature measurements. The ardometer is a combined radiation pyrometer with thermo-electric principle. The method of attaching the ardometer and controls, and measuring and recording the temperature in a glass tank are described and illustrated. A discussion on the use of base metal thermocouples in annealing furnaces is included. R.A.H.

Danger points in the preparation of mirror coatings. WALTER MEYER. *Sprechsaal*, **61** [31], 599–601 (1928).—A discussion on the reactions occurring during the preparation of coatings for silvering mirrors, the dangers incident to the preparation of certain highly explosive mixtures (fulminating silver) and their application. R.A.H.

Experiments on acceleration of glass melting. W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **12** [46], 134–38 (1928).—Ammonium salts accelerate the melting rate and, in the case of chloride and sulphate, also the refining rate. Ammonium sulphate is more effective in increasing the melting rate when used in pot furnaces than when it is used in tank furnaces. L.A.P.

Silica deposit. ANON. *Cement, Mill, and Quarry*, **33** [1], 57 (1928).—Eastern Silica and Chemical Corp., Winchester, Va., recently became the owner of 18 acres of land which contains glass sand deposits. The deposits are located in the western section of Winchester county. E.P.R.

Measurement of the expansion of glasses by the Chèvenard dilatometer. EMILIO DAMOUR AND G. THURET. *Chimie et ind.*, **Special No.**, 436–38 (April, 1928). (*C.A.*)

BOOKS

Volumetric Glassware. V. SCOTT. H. F. and G. Witherby, London, 1928. Price, 20*s*, net. In a prefatorial note S. quotes J. W. Mellor: "It is not at all uncommon to find that the weights in a laboratory have been subject to wide scepticism, while the volumetric instruments have been accepted with blind faith and conversely." The improvement of this state of affairs in regard to the reliability of volumetric glassware is in progress along lines indicated in the book. Attention is directed to the confusion due to the use of two distinct types of units of volume, those based directly on units of length and those defined in terms of space occupied by a specified quantity of water. Owing to this, the term "cubic centimeter" has become so misused that there is a very real advantage in employing the milliliter as the unit of volume for volumetric glassware. This is done throughout the book, and formulas and tables are supplied to counteract the variations in dimensions due to changes of temperature. An account is then given of the testing of measuring flasks, graduating cylinders, pipettes, and burettes. The marking and graduating of volumetric glassware is also described. A chapter on the effect of apparatus errors on the results of volumetric analysis shows in various ways the importance of accuracy. The main theme, however, is the detection of faults and not the indication of how they may be avoided; this is left to the manufacturers, who, doubtless, have their own methods. A final section, more than one-fourth of the book, is occupied by a useful series of calibration tables. The work is well illustrated and arranged, and of a valuable character within its scope. Reviewed in *Pottery Gaz.*, **53** [618], 1952 (1928). E.J.V.

The Practical Glassmelter. ANON. 3rd ed., 285 pp. Published by *Die Glashütte*, Dresden, Germany. Price 10 M., postage additional. A treatise on the preparation and melting of every kind of glass, and a collection of 450 tested glass recipes. Among the number of German books devoted to the practical side of glassmaking, the present volume ranks high. The opening chapter is devoted to the classification of the various kinds of glass, and to a general definition of what glass is. The other chapters deal with raw materials, batch composition, the melting process (including glass defects), and finally with the physical and chemical properties of glasses. The 450 batches are divided into 1 to 168 colorless glasses, and 169 to 450 colored glasses. The latter include transparent and opaque colored glasses. The reading of this book is recommended to all interested in glass manufacture, whether they consider glassmaking an art, or whether they believe that the laws of nature also apply to this branch of human endeavor, and therefore can be investigated, understood, and applied. An English translation of this valuable and interesting book would mean a great deal to the English-speaking countries. Reviewed in *Glass Ind.*, **9** [12], 277 (1928). E.J.V.

PATENTS

Transfer device for glassware. GEORGE E. ROWE. U. S. 1,691,497, Nov. 13, 1928. In a device for transferring glassware from a receiving station to a delivery station, means for gripping the ware, means for revolving it about a horizontal axis to transfer it from the receiving station to the delivery station, and means for rotating the ware about its vertical axis during such transferring movement.

Apparatus for controlling molten-glass flow. CHARLES B. KINGSLEY. U. S. 1,692-306, Nov. 20, 1928. In combination with a flow spout of a glass tank, a gate comprising

nested conduit members adapted to extend across the pouring passage and to be submerged in the molten metal.

Method and apparatus for feeding glass. KARL E. PEILER. U. S. 1,692,464, Nov. 20, 1928. In a glass feeder, the combination with a glass container having a submerged orifice, of a tubular throttling element having its lower open end adjacent to the upper end of the orifice, the internal diameter of the element decreasing upwardly, and means for creating a periodically fluctuating gas pressure below the orifice.

Glass-feeding mechanism. RICHARD LA FRANCE. U. S. 1,692,553, Nov. 20, 1928. The combination of a receptacle for molten glass having an outlet through which the glass is discharged, a device operable periodically to control the discharge, a series of stops to limit the movement of the controlling device, and automatic means to bring the stops successively into operative relation to the device, the stops being individually adjustable to selectively vary the extent of movements of the controlling device.

Sheet-glass drawing apparatus. JOSEPH A. REECE. U. S. 1,692,569, Nov. 20, 1928. In an apparatus for drawing sheet glass, a pair of rotatable cylindrical coolers at opposite sides of the sheet, each rotary cylindrical cooler provided with a longitudinally fluted outer surface, which is arranged out of contact with the glass.

Method of and apparatus for drawing glass. ARTHUR E. SPINASSE. U. S. 1,692,585, Nov. 20, 1928. In an apparatus for drawing sheet glass, the combination of a furnace having molten glass therein, a segregating member placed in the molten glass for creating a restricted area from which the sheet is to be drawn, means for drawing the sheet from the restricted area, independent adjustable shields surrounding the restricted area for locally controlling the temperature of the glass from which the sheet is drawn whereby the restricted area may be kept at a uniform drawing temperature throughout, and means for controlling the temperature of the segregating member at diametrically opposite points and in line with the sheet being drawn whereby the glass forming the edges of the sheets is caused to adhere to the segregating member and the full width of the sheet maintained thereby throughout the drawing operation.

Method and apparatus for producing charges of molten glass. LEONARD D. SOUBIER. U. S. 1,692,589, Nov. 20, 1928. The method of producing formed charges of molten glass which comprises causing the glass to flow from a supply body through an outlet orifice, applying pneumatic pressure to a surface of the glass beneath the orifice, confining the pressure to a narrow annular surface between the main body of the issued glass and the walls of the orifice, and periodically severing the column of glass below the point of application of pneumatic pressure, to form charges.

Sheet-glass downflow apparatus. JAMES C. BLAIR. U. S. 1,692,615, Nov. 20, 1928. In an apparatus for producing sheet glass, the combination of a container for molten glass provided with a submerged elongated discharge outlet wider at each end than at its center, and means below the outlet and adjacent the end portions thereof for engaging the edge portions of the sheet to hold the same to width.

Laminated glass and process of producing. WILBUR F. BROWN. U. S. 1,692,619, Nov. 20, 1928. The process of producing laminated glass, consisting in uniting sheets of glass having wave formations therein, in a manner that the formations in the sheets of glass extend in substantially the same direction in the finished laminated sheet.

Sheet-glass apparatus. NESTOR NAMBOURG. U. S. 1,692,673, Nov. 20, 1928. In a sheet-glass apparatus, means for drawing a sheet from a mass of molten glass, and a lip tile arranged above the molten glass, a support therefore, the lip tile comprising several sections threaded on the support.

Machine for forming glass articles. JOHN E. MCLAUGHLIN. U. S. 1,692,680, Nov. 20, 1928. In a glass-forming machine, the combination of means for suspending a parison of glass while in a plastic condition, and means for directing cooling air against

one side of the parison comprising air nozzles arranged to direct blasts of air in convergent directions such that the air blasts are united in a stream of air directed against one side of the parison.

Method and apparatus for forming sheet glass. JOSEPH A. REECE. U. S. 1,692,702, Nov. 20, 1928. In an apparatus for producing a continuous sheet of glass, a tank for containing a mass of molten glass, an end wall extending inwardly and rearwardly thereof, the wall having an orifice therein, and a sheet glass rolling means associated with the orifice.

Manufacture of glass. EDWARD T. BROWN. U. S. 1,692,813, Nov. 27, 1928. The method of manufacturing plate glass continuously consisting of allowing the molten glass to flow from the melting tank through a spout of substantially the width of the glass desired onto a moving conveyer, thence between the conveyer and a roller to reduce the glass to a predetermined thickness, then through a leer to temper and harden the glass, then between pulling devices which draw the glass through and out of the leer.

Glass-working apparatus. KARL E. PEILER. U. S. 1,692,858, Nov. 27, 1928. In combination with a receptacle for segregating charges of molten material by suction, a severing mechanism adapted to separate charges of molten material collected by the receptacle from a body of such material, the severing mechanism including shear blades spaced below the receptacle, and means for adjusting the severing mechanism toward and from the receptacle to regulate the size of the charges.

Glass-forming machine. ALBERT N. CRAMER. U. S. 1,693,069, Nov. 27, 1928. (1) In a glass-forming machine, the combination of a rotary mold carriage, molds thereon, each comprising separable sections, hollow arms carrying the sections, hollow shafts on which the arms swing for opening and closing the molds, the hollow shafts and arms providing communicating air passages through which cooling air is supplied, means for distributing cooling air to the hollow shafts, means for directing and cooling air from the arms against the mold sections, and manually adjustable valves individual to the hollow shafts for controlling the air supply therethrough. (2) The combination of a rotatable mold carriage, a series of mold bottoms tiltably mounted thereon, cams individual to the mold bottoms for controlling the tilting of the mold bottoms, a stationary cam, and means operated thereby to cause the individual cams to coöperate in succession with the mold bottoms to effect the tilting of the mold bottoms in succession. (3) A mold carriage, body molds, turn-over units each including a neck mold and a support therefore, shafts supported on the mold carriage and supporting the units, and manually operated means for withdrawing the shafts endwise from the units and permitting the latter to be removed bodily from the mold carriage independently of the body molds. (4) A rotatable carriage, a part mounted thereon for a limited reciprocating movement radially thereof, a stationary cam, operating connections between the cam and the part for causing the rotation of the carriage to effect the reciprocating movement, the connections comprising a rod having sections relatively movable in a direction lengthwise of the rod, springs placed under compression, respectively, by the lengthening and shortening of the rod, and means to prevent either spring from expanding while the other is being compressed. (5) The combination of a continuously rotating mold carriage, blank molds and finishing molds thereon, a turnover unit comprising a neck mold, means for oscillating the unit to swing the neck mold between the blank mold and finishing mold, and means including rack and pinion mechanism permitting removal of the unit from the mold carriage independently of the blank molds and finishing molds and without interrupting the continuous rotation of the carriage.

Glass-blowing machine. MAX JAEGER. U. S. 1,693,843, Dec. 4, 1928. (1) In a glass-blowing machine a wind chest comprising a pair of relatively movable walls, and a spring pressed gasket for minimizing leakage between the walls, the various elements of

the spring pressed gasket being separate from the walls. (2) A rack, a spring biasing the rack in one position, a cam adapted to move the rack in opposition to the spring, a pinion engaged by the rack, an arm attached to the pinion, and a blowhead carried by the arm. (3) A glass machine comprising a continuously rotating mold table, a plurality of split molds on the mold table, a blow-head for each of the molds, a solid ring mold movable with respect to the blow-head and a split ring mold for each of the molds, the blow-heads being operable to blow air through the solid ring molds, and a cam for moving the solid ring mold vertically.

Method of manufacturing electric bulbs and bulb blanks for use therein. CLYDE C. BOHNER. U. S. 1,694,368, Dec. 11, 1928. Method of manufacturing electric bulbs which consists in forming in the elongated neck of a bulb blank and in the plane of the seal and bulbous ring to cause a thinning of the glass walls thereat, assembling a mount within the bulb blank with the sealing flange of the mount disposed in the plane of the bulbous ring and then heating the latter to cause it to collapse upon and become welded to the flange while the lower part of the neck causes a still further thinning of the glass walls in the plane of the seal by the stretching thereof.

Glass-blowing machine. CLARENCE R. NIXON. U. S. 1,694,486, Dec. 11, 1928. In glass-blowing machine, a combined slug support and neck mold adapted to form a mold bottom, a primary blank mold having hinged sections movable to close on and open from the neck mold, a secondary blank forming mold also movable to close on and open from the neck mold, means to effect successive closing and opening of the primary mold, and closing and opening of the secondary mold, means to retain the neck mold in fixed position during the opening and closing of the primary and secondary molds, a finishing mold adapted to open and close at a point remote from the point of opening and closing of the primary and secondary mold, the neck mold retaining means including elements arranged to move the neck mold into coöperative relation with the finishing mold subsequent to the opening of the secondary mold and prior to the closing of the finishing mold, and means to open and close the finishing mold.

Process for the manufacture of glass containing barium. FRITZ ROTHE AND HANS BRENEK. U. S. 1,694,831, Dec. 11, 1928. Process for the manufacture of barium glass which consists in melting barium silicate with glass-forming ingredients.

Glassworking machine. ALEXANDER SAMUELSON. U. S. 1,694,867, Dec. 11, 1928. In a glassworking machine, the combination of manipulators for a blank mold, a neck ring, and a blow mold, a blow mold carrier, means for moving the blow mold carrier to shift a blow mold into and out of blowing position, means controlled by the movement of the blow mold carrier for controlling the application of motive power to the blow mold manipulator, means controlled by the movement of the blow mold manipulator for controlling the application of motive power to the neck ring manipulator and means for controlling application of motive power to the blank mold manipulator.

Reinforced glass. P. J. PORT AND J. NEWTON. Brit. 296,825, Oct. 31, 1928. Reinforced glass is made by coating one face of each of 2 glass sheets with a solution of albumen in distilled water, drying the coated sheets, and applying pyroxylin in an ether or absolute alcohol or amyl-acetate solution and again drying. The coated surfaces are then united under suitable pressure at a temperature of 40 to 50°C to a celluloid sheet which has been immersed in a solution of dimethylamine in spirit. A small quantity of acetic acid may be added to the dimethylamine solution. The edges of the compound sheet may be sealed by celluloid or collodion solution.

Glass manufacture. S. HUNT. Brit. 297,142, Nov. 7, 1928. Machines which gather charges of glass by suction contain means for adjusting the height of the cut-off knife which severs the thread of metal that trails from the parison mold after making a gather. The knife is secured to the lower end of a vertical shaft which is rotatably

mounted in a bore formed in an arm of the machine frame. A nut screws onto a threaded portion of the shaft, and a ball thrust bearing is interposed between the nut and the upper surface of the shaft. A bracket prevents the nut from moving longitudinally while permitting it to rotate. A saddle slides on the shaft and is formed with a feather which permits it to move longitudinally while causing it to turn with the shaft. The upper surface of the nut is formed with notches or slots and a detent pivoted on the saddle can engage in one of these notches. Thus, by raising the detent, the nut can be turned to raise or lower the shaft to adjust the position of the knife to suit the parison mold. After adjustment, the detent is turned down to engage a notch and thus locks the nut in relation to the shaft.

Glass manufacture. S. HUNT. Brit. 297,143, Nov. 7, 1928. A forming machine of the type in which metal is gathered into the parison mold by suction, contains means for cooling the knife which cuts off the thread of metal that trails from the parison mold after it has made a gather. The knife blade is secured to the lower end of a vertical shaft carried by a hollow arm through which cooling air is supplied. The shaft is journaled in a casing which is fitted into a bore in the arm, and air passes from the arm down through the casing and escapes through an outlet. The flow of air cools the shaft, and the outlet is so shaped as to direct the escaping air on to the blade when the latter is in its inoperative position. A pipe is provided to enable lubricant to be supplied to the lower bearing of the shaft.

Glass manufacture. S. HUNT. Brit. 297,340, Nov. 14, 1928. Relates to machines for making glassware, particularly rotary suction-gathering machines in which cams are used for controlling the movements of the molds in opposition to spring or other applied pressure or gravity. Means are provided for throwing the operative portions of such cams into or out of action, whether the machine is working or not, and preferably by means under the control of the machine minder.

Compound glass and like sheets. ROHM AND HAAS AKT.-GES. Brit. 297,413, Nov. 14, 1928. Unsaturated organic compounds which are polymerized or polymerizable to a solid form are united to glass, enamel, metal, porcelain, etc., to form splinterless compound sheets or mirrors, etc. Two examples are given: (1) a layer of methyl ester of cinnamic acid is placed between two glass sheets and exposed to light to cause polymerization; (2) a plate of 4 mm. thickness of polymerized ethyl ester of crotonic acid is placed between two sheets of glass and united thereto by pressure at 90°C. The organic compound may be applied in solution, the solvent being removed by evaporation. Heat and pressure may be varied to prevent formation of bubbles. Strengthening, or coloring materials such as azo dyes, metal powders, etc., may be added to the organic compounds.

Glass manufacture. LAX AND SHAW, LTD., J. F. SHAW, AND J. E. BRANFORD. Brit. 297,481, Nov. 14, 1928. Relates to a bottle-making machine of the Owens type and particularly to the means for operating the molds and associated parts. The machine comprises a frame preferably mounted on wheels so that it can be moved from one place to another, and a central vertical column carrying ball bearings on which skeleton platforms rotate. Each platform comprises a number of arms radiating from a hub, and corresponding arms on each platform are joined to one another by pairs of upright plates. The structure thus formed is rotated about the column by a motor through gearing which engages a circular rack secured to the lower platform. Each pair of plates forms a frame or support for the molds of a unit, and either plate can be removed to facilitate repairs or replacements. Between each pair of plates, a bent lever is pivoted on a shaft. A finishing mold is mounted on the outer end of the lever while a counterweight is secured to the inner end. A toothed segment is secured to the hub of the lever and is engaged by a rack formed on a rod which slides through bearings on the platform. A fixed cam

ring engages rollers on the lower end of the rack rod, so that the mold is raised or lowered as the machine rotates. In its raised position, the mold is supported by a roll which runs on a circular plate carried by standards. The mold is closed, when it is raised, by a roll carried by a slide which engages the outer edge of a cam plate secured to the plate. The mold is opened, to discharge a finished bottle, by a fixed upright having an inclined surface which engages the roll and thrusts it inward. Each parison mold is made in halves carried by lever arms, and these arms are pivoted below a block that slides vertically between the upright plates. The block, which has an extension that forms a suction head, is connected by an adjustable link with one end of a lever pivoted to the upper platform. The other end of the lever carries a weight which counterbalances the weight of the mold and its associated gear. A toothed segment secured to the hub of the lever is engaged by a rack which is moved by a cam fixed to the column so that the rotation of the machine raises or lowers the parison mold. The inner ends of the parison mold arms are connected by links to a vertical loop-shaped member which is engaged by a pin on the end of a slide. A roll on the slide engages a cam fixed to the column, so that the mold is opened and closed by the rotation of the machine. The member allows vertical movement of the mold relative to the slide. A ring mold in parts, is pivoted on the underside of the extension of a block. It is opened by cams rotated by a rod and is closed by a spring. The extension is formed with an aperture to allow the passage of a rod which carries the neck-ring plunger, and is fitted on its upper side with a cover or cap which is connected by pipes to a distributor valve. The valve controls the application of suction and compressed air. A blade carried by a rotary shaft is provided to cut off excess glass as the mold is lifted after making a gather.

Glass manufacture. S. HUNT. Brit. 297,490, Nov. 14, 1928. Relates to a device for connecting a ring mold to the blow-head of a machine in order to resist the tendency of the mold to be forced away from the underside of the blowhead, thus preventing loss of blowing pressure. The halves of the ring mold, which are pivoted on a pin carried by the blowhead, are formed with grooves or projections that engage projections or grooves on a pin carried by the blowhead. The grooves on the mold halves are so arranged that they engage the projections as the mold is closing and become disengaged as the mold is opened, and they are so shaped that the clearance between the mold and the blowhead is progressively reduced as the mold is closed. The pin may serve to centralize the mold in relation to the blowhead.

Glass manufacture. S. HUNT. Brit. 297,491, Nov. 14, 1928. A machine of the suction-gathering type is provided with stop mechanism for arresting the upward movement of the parison mold, after it has gathered a charge of metal, and for acting as an abutment for withstanding the thrust of the knife as it shears through the metal trailing from the mold. The stop is removed after the cutting-stroke in order to allow the mold to continue to rise so that the knife, on its return stroke, does not touch the mold bottom. The parison mold is supported by parallel levers which are pivoted on an adjustable slide and carry a counterbalance weight. A cam roll resiliently supported by the weight engages a fixed cam track which causes the raising and lowering of the parison mold as the machine rotates. The upward movement of the mold is arrested by a stop mounted on a screw of quick pitch which passes through brackets secured to the slide. A pinion secured to the screw is engaged by a longer pinion mounted on a vertical shaft which is rotated by a rack and pinion from a fixed cam. In operation, when the mold rises after making a gather, part of the lever descends until it is arrested by a stop. The knife then shears through the metal trailing from the bottom of the mold and the thrust of the blade against the bottom of the mold is taken up by the stop. The movement of the machine then carries the mold past a rise in the cam which moves the rack and lowers the stop. The mold is then enabled to continue its upward movement away from the path of the knife.

Cams; glass-blowing machines. S. HUNT. Brit. 297,700, Nov. 21, 1928. In rotary machines for the manufacture of blown glass articles such as bottles, in which carrier units rotate about a central column and blowing or equivalent valves on the units are actuated by follower levers riding against a fixed central cam comprising a number of stepped layers or having a stepped, coned, etc., surface; the follower levers are mounted about axes parallel to the cam axis and carry bowls or rollers with means whereby any individual follower lever or cam bowl can be adjusted to coöperate with any cam step without modifying the effective length of the follower lever arm. Where the movements are transmitted to the valves through secondary levers, means are also provided to maintain constant the stroke relations thereof for all adjustments of the cam controlled elements.

Cams; glass-blowing machines. S. HUNT. Brit. 297,763, Nov. 21, 1928. Relates to the formation of a stepped cam for use in machines for the manufacture of glass articles of the type in which a framework carrying bottle-making units rotates around a cam on a fixed column and follower levers controlling blowing valves or other parts on the units are set to coöperate with any desired step of the cam. The cam is formed of a number of layers corresponding to the number of steps required, and each layer is composed of any required number of segmental elements adjustable individually to regulate the operative contour.

Pressing glass. WHITALL TATUM CO. Brit. 297,794, Nov. 21, 1928. A press, particularly intended for making electric insulators having an internal screw thread comprises a number of molds mounted on a rotary table, and each mold is provided with a plunger, or plug, which is forced into the mold by a press head and is afterward screwed out of the finished article by a separate device, the article being left in the mold ready to be removed by a take-out device.

Lenses. C. ZEISS. Brit. 297,823, Nov. 21, 1928. Photographic objectives corrected for spherical aberration, chromatism, astigmatism, and coma, consisting of 4 lenses, separated by air, of which the 2 outer ones are collective and the 2 inner ones dispersive and distinctly meniscus in form, have the collective lenses facing the image distinctly biconvex and the other collective lenses constructed with radii of curvature, the ratio of which is algebraically larger than that of the corresponding ratio of the radii of the collective lenses facing the image. The front collective lens is a meniscus lens. The radius of curvature of one of the boundary surfaces of the intermediate air lens is at least 10% larger than that of the other boundary surface. The double convex collective lens is of glass of refractive index not less than 1.61 or when consisting of a cemented doublet the average of the refractive indices of the elements is at least 1.61. Numerical data are given for a lens having an aperture of 1:1.4.

Glass furnaces. UNITED GLASS BOTTLE MANUFACTURERS, LTD., AND T. C. MOORSHEAD. Brit. 297,856, Nov. 21, 1928. In a glass-melting furnace having a channeled forehearth through which the glass is circulated by a paddle and from which the molten metal is withdrawn by a bottle-forming machine of the suction type, the paddle is arranged between two dams, the former being disposed at or near the gathering point and the latter in the return arm of the forehearth channel adjacent the furnace. The inlet arm of the channel is fitted with a refractory plug which is adjustable vertically to control the temperature of the metal entering the forehearth. The driving gear for the paddle is arranged so that the toe of the latter travels in an elliptical path and comprises a shaft which is driven by a chain-wheel either by an independent motor or from the bottle-forming machine and which carries a crank having a pin engaging one end of a connecting-rod, the other end of which has a cross-pin attached to blocks slidably mounted in guides. Mounted to swivel on the rod is an eye-bracket supporting a rod to which is adjustably secured the paddle holder. A second connecting-rod is pivoted on the rod and to a crank on the pin, this arrangement insuring that the rod and paddle are

always maintained in a vertical position. The forehearth is, except at the gathering point, provided with a cover formed with an opening to allow movement of the agitator, this opening being covered by refractory tiles, which are fitted with wheels, running on rails and are attached to the holder by slotted brackets and pins.

Glass annealing leers. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD., T. WARDLEY, AND H. V. E. RENN. Brit. 297,865, Nov. 21, 1928. In a muffle leer for annealing glassware the cross-section of the longitudinal flue for the temperature controlling medium is varied without altering the surface area of the heat-transmitting wall of the flue at points where it may be desired to vary the rate of heat transference from the flue to the ware. The flue may be permanently constructed at the desired point, or adjustable plates operated by a hand control may be fitted to provide for a gradual increase in the depth of the flue in both directions. Control of the temperature conditions in the leer may be effected by admitting cold air to the flue through inlets.

Compound glass. N. B. MATTINGLY AND A. REA. Brit. 298,423, Nov. 28, 1928. Compound transparent sheets are formed by joining sheets of glass to a sheet of cellulose acetate or like material by means of an adhesive consisting of caoutchouc with or without gum dammar and gum mastic with gradually increasing pressure and heat in a hydraulic press, the platens of which are heated by steam or hot water. The platens are raised in the center by padding with blotting paper to expel air. The temperature is raised to 148 to 177°F and the pressure to 100 lbs. per sq. in. and maintained for 15 minutes. The sheets are then removed for cooling preferably on a heated tray. An adhesive may consist by weight of caoutchouc 1, gum dammar 4, gum mastic 12, chloroform 50, benzine 10, which when mixed is thinned by 50% amyl acetate. The gums are dissolved in ethyl alcohol. Plate glass is about $^1/_{10}$ in. thick or 15 to 18 oz. Window glass may be used. The glass is cleaned by hot soda water, rinsed, dried, and further cleaned with naphtha and polished. The cellulose acetate sheet is 0.01 to 0.04 in. thick.

Heavy Clay Products

Vanadium and molybdenum compounds in clays. L. A. PALMER. *Jour. Amer. Ceram. Soc.*, **12** [1], 37–47 (1929).—Eight clays and shales containing small amounts of insoluble vanadium and molybdenum compounds were studied. During firing, soluble salts of these elements were formed which later appeared as a green-yellow efflorescence. The color of the efflorescence was chiefly due to alkali vanadates. Either sodium fluosilicate or calcium fluoride is effective in eliminating the green-yellow efflorescence. The use of these chemicals is usually a more economical procedure than either hard firing or the use of lead compounds. The results of various trial firings made with clays to which were added varying amounts of several different chemicals are given.

Machines for extruding clay columns: augers, spacers, and dies for brick machines. PAUL C. GRUNWELL. Bur. Stand., *Jour. Research*, **1** [6], 1023–57 (1928).—Marked changes in the flow pressure for plastic clay or shale in the stiff-mud state are coincident with changes in the moisture content in the region of the point of optimum plasticity. The weight per volume of clay extruded increases with decrease in moisture content of the clay, increase of die taper and length of die, and appears to be almost independent of length of spacer. The weight per volume of extruded clay is also greater for dry dies and for lubricated dies. The output in weight of extruded clay per unit of power used varies inversely as the length or as the taper of the brick die, or the length of the collective spacer, being much less for variations in taper of die or length of collective spacer than for a corresponding change in the length of the die. With the medium plastic clay used the single-wing auger was more efficient in power consumption than the double- or triple-wing auger. The principal difference in the performance of the single-, double-, and triple-wing augers lies in the friction losses due to the material sliding through the mul-

tiple wings. This is greatest for the triple-wing and least for the single-wing auger. The efficiency of double- and triple-wing augers when working clays of medium plasticity was approximately the same, whether based on output per unit of power or per unit of time. The performances of the three augers are as follows: The single-wing auger extrudes a greater weight of clay per unit of power than the other two, but must be farther from the die to overcome uneven flow. The double-wing auger reduces uneven flow by giving more even pressure to the clay column. The triple-wing gives a more even pressure through the die than either of the others, but occupies slightly more space in the auger barrel, develops more friction, and is not as efficient for short, lean clays. For producing a clay column free from objectionable defects, the combination giving the maximum quantity of material extruded per unit of power was a single-wing auger, with an 8-inch spacer and a 6-inch die, whereas the maximum quantity of material extruded per minute was obtained with a triple-wing auger, an 8-inch spacer and a 6-inch die. The following observations as to the probable advantages and possibilities of the apparatus developed and used for this work seem justified: (1) It will measure small differences in the torque required to extrude clay and shale of different plastic consistencies under varied conditions of operation of auger, spacer, and die equipment. (2) It affords a practical means of studying the workable characteristics of clays and shales and provides a reliable method of determining the auger and die equipment best suited to their physical properties and the class of product to be manufactured. (3) It can be used to study the effects of various lubricants on power consumption, quantity output, and quality of product. A very complete bibliography of publications related to this subject is included. R.A.H.

Strength tests for bricks. W. N. THOMAS AND N. DAVEY. *Brit. Clayworker*, **37** [439], 318–27 (1928).—To insure satisfaction in bricks, it is desirable that in addition to porosity tests and other requirements, some form of strength tests shall be specified. Data are given on the following tests: (*a*) crushing tests upon specimens cut from the bricks to be tested; (*b*) crushing tests upon whole bricks or half bricks; (*c*) effect of shape of specimen; (*d*) the effect of different bedding materials; (*e*) effect of different fillings in the frog; (*f*) ratio of the apparent strength per unit area of a whole brick to that of a half brick; (*g*) comparison of relative strengths of different types of brick; (*h*) crushing tests on built-up blocks. All the usual crushing tests are open to serious objection, whether their aim is to ascertain the strength or relative strength of brick material, or to ascertain its strength as a building unit. Crushing tests of whole or half bricks on edge are open to the objections that (1) the strength on edge does not necessarily bear the same relationship to the strength on the flat for all bricks; (2) the loading is only symmetrical when there is no frog, or when a whole brick with two frogs is tested. Bending tests on edge are little affected by the frog, but the strength in this direction may not be a constant factor of the strength on the bed. It is suggested that the most satisfactory test is the bending test on the flat with the frog unfilled. The modulus of rupture calculated from the results, and allowing for the frog is an indication of the quality of the material and as the filling of the frog cannot always be relied upon in practice, it also affords an indication of the strength as a structural unit. R.A.H.

New face brick. ANON. *Arch. and Bldg.*, **60** [3], 100 (1928).—A light colored face brick named "Blondes" has been recently introduced by the Streator Brick Co., Streator, Ill. The colors of the "Blondes" range from olive gray to the lighest amber or champagne tones and these brick are shot through with high lights, giving a sun-spotted effect. They are made from Streator shale and the embossed varieties are unusually resistant to dirt and dust. E.P.R.

Hollow sand-lime brick. ANON. *Cement, Mill, and Quarry*, **33** [2], 82 (1928).—In recent years, many sand-lime brick manufacturers have been seeking a strong cored

brick which would be suitable for load-bearing walls. Several types of hollow brick have been used in Germany for partition walls and only recently has a process been developed whereby brick of these types with sufficient strength can be produced. Hollow sand-lime brick are now being produced in large quantities, the unit weight running between $5^1/_2$ and $6^1/_2$ lbs., the difference in weight depending on the number and size of the hollow spaces. The compressive strengths of these bricks are quite significant and in proportion to their weight; *e.g.*, a hollow sand-lime brick weighing $6^1/_2$ lbs., showed a compressive strength of 2630 lbs. per sq. in. and the $5^1/_2$-lb. brick showed between 1630 and 1700 lbs. per sq. in. The $5^1/_2$-lb. brick can easily be designated as a light-weight brick. There are other advantages to the lightweight brick such as its better insulating properties, it being a poor conductor of heat. At the present time a series of investigations is under way to determine just how this nonconduction of heat compares with the usual solid sand-lime brick. In terms of material, the hollow brick represents a savings of about 25%, the amounts of lime and sand needed being decreased proportionately by this figure. Further developments on the process of manufacture are expected to be reported within a short time. E.P.R.

Hollow tile plant. ANON. *Brick Clay Rec.*, **73** [11], 746–56 (1928).—The plant of the Darlington Fireproofing Co. is a modern unit with unusual features for making hollow tile. These include aerial tramway, forced draft system on the kilns, a unique drier of the tunnel type, a steel off-bearing belt, efficient speed reducer installation, novel feeder set-up, novel screen design, etc. This plant is better equipped mechanically than most tile factories. The various features are discussed in detail and illustrated. E.J.V.

New type closed end tile. ANON. *Brick Clay Rec.*, **73** [11], 757 (1928).—Because of the outstanding advantages in safety, economy, and dead weight that a closed end floor tile would afford, the clay industry has sought for years for some practical method of manufacturing it, with no success. Finally, S. F. Heckert (a practicing architect) designed and perfected a process permitting the quantity production of 12x12-in. units, in depths for all standard floors. This special manufacturing process produces a unit that is entirely inclosed in a solid tile shell, strengthened by the usual interior tile webs. This tile is especially adaptable to two-way combination floor systems, consisting of 4- or 5-in. reinforced concrete joists, spaced 16 to 17 in. on centers in two directions at right angles to each other, with the tile between the joists. A monolithic concrete topping may be used, depending on the designer's requirements. In ordinary construction there is a considerable waste factor (sometimes exceeding 20%) due to the concrete running into the open ends of the tile. Because of this waste, the dead load of the floor itself is increased which in turn increases the size of beams, columns, and footings. This increase in dead load cannot be accurately determined. Through the use of the closed end tile, however, this waste is eliminated; and the dead weight can be predicted with certainty, based on the true sectional area of the joists and the known weight of the tile. There are the additional features of obtaining a strictly fire-proof construction, having a highly desirable base for a plastered ceiling, ease in laying, and a minimum depth of floor and supporting beams. E.J.V.

Cleveland Clay League. ANON. *Brick Clay Rec.*, **73** [11], 760–62(1928).—Considerable progress is reported by the Cleveland Clay League during the past year in its work of certifying (Cleveland-made) all brick and tile walls which meet its requirements for first quality materials and workmanship. The purpose of the League, which is supported by local brick and tile manufacturers, is to promote better and more enduring homes made of Cleveland brick and tile. A skeleton bronze brick was developed containing the wording "Cleveland-Made Certified Masonry Walls." It is set in the exterior wall of a home or other building somewhere near the entrance, or chimney, often

as a cornerstone. It stands as a label or trade-mark in the wall of the home, which insures its quality inside as well as what can be seen on the surface. The best statement of the standards of materials and workmanship required by the Clay League for certification are contained in its certificate which reads in part: "This building is eligible to be thus distinctively marked [by the placing of the bronze brick] and permanently identified for its superior masonry construction, because its walls, both those portions visible in the finished structure and those which cannot be seen, are of fire-safe materials, have a high factor of safety, are built in accordance with the provisions of the building code, and are of permanent, Cleveland-made products." E.J.V.

Bring plant problems to Roseville. GEORGE A. BOLE. *Brick Clay Rec.*, **73** [12], 827–28 (1928).—The work of the O. S. U. Engineering Expt. Sta. at Roseville has to do more particularly with the interpretation of research already available to the industry and to plants applying research to specific plant problems whether they have to do with product or process. It is not the purpose to, under any circumstance, permit researches to fall short of plant proving and it is an earnest hope that they will be plant applied by the industry at large. The work at Roseville can be divided into two general heads: (*a*) research and (*b*) service. While the major aim has to do with plant application of existing data, research of a fundamental nature is not intended to be omitted. The service idea is developed along two lines: service in equipment and personnel, and the offering of advice based on either theory or experience which will lead to the solution of a problem on the plant without any work being done at Roseville. An outline of the various problems that are being attacked and have been taken up at the station is given. E.J.V.

Lytag. FRANK A. GLASS. *Brick Clay Rec.*, **73** [12], 829–30 (1928).—Sintering, a simple, rapid, and efficient metallurgical process, has entered the field of the ceramist, in the production of light-weight vesicular clay aggregates known by the trade name of Lytag. Shale, for example, is crushed in dry pans or hammer mills, a small proportion of granulated coal is added, and both are thoroughly mixed and moistened in a high speed pug mill. This mixture in nonplastic condition is spread loosely and uniformly on grates over suction chambers connected to a fan. The fuel particles on the exposed surface of the charge are then ignited by a flame applied for a half minute. Thereafter, under the influence of a downward draft maintained through the charge, combustion proceeds progressively in a thin zone without flame. Air for combustion is drawn through sinter, heated to the temperature of fusion, and becomes preheated by the time it reaches the glowing carbon in the fire zone. Meanwhile, the carbon in the fire zone has been brought to a glowing condition and the adjacent clay particles highly heated by the passage of gases of combustion liberated when the fire zone was at a slightly higher elevation. E.J.V.

Fired clay in modern construction. H. GILARDONI. *La Céramique*, **31** [483], 117–26 (1928).—A paper presented to the International Congress of Masonry and Reinforced Concrete discusses in detail the use of clay products in building walls, floors, and roofs, giving in each case the history, types, modern developments, and designs. The tendency is toward larger units. G. characterizes this age as the age of hollow tile. A.E.R.W.

Cause and prevention of kiln and dry-house scum and efflorescence on face brick walls. L. A. PALMER. *Ber. deut. keram. Ges.*, **9** [9], 514–19 (1928); *Brick Clay Rec.*, **73** [12], 822–24 (1928); see also *Ceram. Abs.*, **7** [10], 687 (1928).

PATENTS

Building block and construction. JOHN EISENMANN. U. S. 17,137, Nov. 20, 1928 (Reissue). A composite brick and hollow tile wall comprising a hollow tile part and a brick facing part including courses of header brick extending into the tile part and 5

courses of stretcher brick laid between adjacent header courses and disposed without the tile part, the hollow tile part comprising blocks all shaped alike and each having horizontal bearing portions formed with an offset equal to half the height of one course of brick and each block having a maximum height equal to the thickness of three brick plus two mortar joints, the blocks being arranged in vertically disposed pairs with the offset bearing portions of adjacent blocks facing each other and bonding the upper and lower faces of the inner ends of the header brick between them and having between them a mortar joint opposite the header bricks, each pair of tile blocks being disposed between like pairs above and below and bearing along mortar joints in the same horizontal plane, which pairs of blocks in turn have bonded between them the inner ends of the next adjacent header courses of brick, the vertical height of each pair of blocks plus the mortar joint opposite the header bricks being equal to the thickness of six brick plus five mortar joints, every header course in the wall being bonded between separate and distinct pairs of blocks and every separate pair of blocks embracing a distinct header course of brick.

Distributing system for brickyards, etc. GEORGE D. WARNICK. U. S. 1,692,970, Nov. 27, 1928. In distributing systems of the character described, the combination of an elevating conveyer with pivoted scooplike carriers each equipped with a series of rollers to support articles thereon, and stationary cam means engageable by the forward roller of each successive carrier to deflect the latter into alignment with a distributing chute for automatic discharge of the carrier content.

Brick machine. FRANK MILLER. U. S. 1,693,179, Nov. 27, 1928. A brick-making machine comprising a plurality of bearings adjacent and at the bottom of a pit, shafts journalled in the bearings, connections between the shafts and means on one of the shafts to transport plastic material from a storage hopper to a plurality of molds.

Brick delivering and stacking means. LAURITZ NEILSEN DYHRBERG. U. S. 1,694,586, Dec. 11, 1928. Apparatus for dealing with bricks including in combination a hinged tray receiving bricks on the flat; a tiltable surface; means for tipping the tray and means for delivering the bricks on end and in rows onto the surface; a stop on the tiltable surface opposite the means delivering bricks in rows thereonto; and means for tilting the surface to bring the rows of bricks thereon into stacked formation on the stop, substantially as described.

Method of making tile clay products and apparatus therefor. HERBERT A. SHUGART. U. S. 1,695,119, Dec. 11, 1928. An apparatus for making roof tiles, comprising a support, a flexible sheet on the support, a removable frame on the sheet adapted to receive and shape a slab of plastic clay, and a tile mold adjacent the slab of clay, the sheet being held down on the support along a line intermediate the slab of clay and the tile mold, whereby on the turning movement of the sheet, the slab of clay is turned upside down to rest on the mold.

Refractories

Insulation of roofs of glass furnaces. ROBERT D. PIKE. *Jour. Amer. Ceram. Soc.*, **12** [1], 56–61 (1929).—It is unjustifiable to assume that a furnace roof cannot be safely insulated. The principal variables controlling the possibility of safe insulation are: (1) temperature of bath below melting point of silica brick roof; (2) transparency of the atmosphere within the furnace, *i.e.*, no possibility of impingement of dense hot flames. The data of this paper are taken from observations on a glass tank furnace in which the combustion rate (B.t.u. per cu. ft. per hr.) is very low. A testing method is described which will show whether or not insulation is safe for any given furnace, considering only the temperature of the inside face of the brick as affected by the application of insulation. The possibility that if the roof is insulated the progress of fluxing of the silica brick by dust and fumes within the furnace may be accelerated because the higher mean tempera-

ture of the brick is considered. In the furnace observed, corrosive dust and fumes were in the gases to a considerable extent, yet no unusual deterioration of the roof brick was noted after three years of insulation under continuous operation.

Specifications for refractories. GEORGE A. BALZ. Amer. Refrac. Inst., *Tech. Bull.*, No. 26.—Specifications become most essential factors in progressive industrial development by serving as targets at which manufacturers are either inclined or compelled to aim. There is a sharp line of demarcation between what the purchaser wants and what the manufacturer can produce, particularly in refractories for more rapid production from industrial furnaces. The balance between the performance demands on refractories and the production cost has perhaps, in many cases, already been struck. An undesirable aspect of specifications is the ever-present danger that they sometimes lead to more or less wide misapplication of refractories. The assumption has been made that the requirements of the larger consumers must be precisely the same as for the smaller consumer with different service conditions. The knowledge that the large consumer uses a specific product, makes the smaller consumer feel secure in the selection of his refractories. Specifications for ingredients, grain size, method of manufacture, and firing of products are hardly logical, especially since it is difficult for even the manufacturer to interpret these factors in terms of their actual effects upon service rendered. The raw materials vary considerably in properties. Each manufacturer must study his materials so as to produce the best possible product for a given class of service. The same mixture of clays, method of forming, and degree of firing are seldom applicable to more than one plant. The coöperation between consumer and manufacturer, in writing of specifications, has been a most important aid in the development of more suitable refractories and a more intelligent application of them. The water-spalling test should be discarded as it does not simulate actual service conditions. F.P.H.

Third supplementary list of articles on refractories. ANON. *Feuerfest*, **4** [6], 98–100 (1928).—A bibliography on refractories covering publications issued during 1927. F.P.H.

Brown silca brick. W. E. GROUM-GRJIMAILO. *Feuerfest*, **4** [7], 105–106 (1928).—The physical properties of a new brown silica brick are described. The chemical composition of such bricks is given as follows: SiO_2 93.68, Al_2O_3 0.19, Fe_2O_3 2.31, CaO 3.21, MgO 0.25, MnO 0.38. F.P.H.

Fusion of fuel ashes. KURT BAUM. *Feuerungstechnik*, **16** [13], 145–49 (1928).—A new method is described for determining the softening behavior of coal ashes. The ash which has been pressed into the form of a cylinder is placed in a cascade type of carbon resistance laboratory furnace. The change in the height of the test piece is determined, as the temperature of the furnace is increased, by means of a special mechanism. The results of the tests are reported in graphical form where the height of the specimen is plotted against the temperature of the furnace. F.P.H.

Properties of materials for use at high temperatures with special references to boilers for superheated steam. BATSEN. *Feuerungstechnik*, **16** [19], 228 (1928). F.P.H.

Action of reducing gas mixtures on fire brick at 1200 to 1400°C. HANS KLAR. *Keramos*, **7** [20], T2 (1928).—A general discussion is given of the action of reducing gases on refractories. F.P.H.

Measurement of expansion of refractory materials up to 1600°C. K. ENDELL AND W. STEGER. *Stahl u. Eisen*, **48** [22], 722 (1928); for abstract see *Ceram. Abs.*, **7** [10], 695 (1928). F.P.H.

Refractory material for the cupola furnace. ALFRED B. SEARLE. *Iron Steel Ind.*, **1** [9], 269–71 (1928); *Stahl u. Eisen*, **48** [26], 875–76 (1928). F.P.H.

Gas permeability of silica brick, mortar joints, and masonry in the Siemens-Martin furnace. HUGO BANSEN. *Stahl u. Eisen*, **48** [29], 973 (1928). F.P.H.

Behavior and requirements of dolomite for steel works. OTTO JACOBS. *Stahl u. Eisen*, **48** [30], 993–95 (1928).—The requirements of dolomite for the Thomas and the Siemens-Martin process are discussed. F.P.H.

Thermal insulation of electric furnaces. M. L. HARTMANN AND O. B. WESTMONT. *Trans. Amer. Elect. Soc.*, **50**, 116–40 (1928); *Feuerfest*, **4** [7], 108–109 (1928). F.P.H.

Graphite in 1927. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 33–38 (1927).—During 1927 the graphite industry in the U. S. advanced on the whole, although the total sales by producers decreased slightly. The increased cost of imported graphite had the effect of stimulating the industry in this country; the number of active producers reporting increased from 6 in 1926 to 9 in 1927, the largest number reporting since 1920. The quantity of natural graphite sold or used by producers in the U. S. decreased from 5470 short tons in 1926 to 5207 short tons in 1927 or 5%. The quantity of amorphous graphite decreased 380 short tons or 13% compared with 1926. Crystalline graphite in 1927 exceeded amorphous graphite in amount sold or used by producers for the first time since 1920. Manufactured graphite in 1927 amounted to 12,257,239 lbs. Statistics are given on prices, production and uses. In addition some space is given to imports and exports. In 1927 the quantity of graphite imported for consumption increased 1286 short tons, or 8% compared with 1926. R.A.H.

Production of magnesia and silica crucibles in the induction furnace. C. N. SCHUETTE. Bur. Mines, *Rept. of Invest.*, Serial No. 2896 (October 1928).—The production of silica and magnesia crucibles in the induction furnace was attempted and achieved in the laboratory of the Pacific Experiment Station of the Bureau of Mines. The essential new parts of this work are the development of a technique for the high-frequency furnace production of silica crucibles of greater wall thickness than could be readily fabricated from commercial fused silica, and for heavy-walled magnesia crucibles of great density and mechanical strength. Detailed drawings of molds used in preparation of crucibles and set-up in the furnace are shown. Method of procedures used in making the crucibles as well as mixes and materials included are given in detail. R.A.H.

Thermal expansion of mullite from 20 to 1800°C. ANON. Bur. Stand., *Tech. News Bull.*, No. 139, pp. 158–59 (1928).—A study of the expansion behavior of mullite prepared from raw materials obtained from various sources was recently completed at the Bureau. The materials are as follows: Mullite prepared from (*a*) andalusite; (*b*) dumortierite; (*c*) Indian cyanite; (*d*) electrically fusing the necessary molecular proportions of alumina and silica. Specimens measured approximately 1x1x6 in. and had been fired to at least 1400°C previous to testing. Each specimen was tested again to observe the effect of the first heating. The upper limit of temperatures used ranged from a minimum of 1670°C to a maximum of 1800°C depending on the action of the specimen. A table is given showing the values and other data obtained on the 4 specimens. The rate of thermal expansion of these various specimens of mullite is approximately the same from room temperature to 1000°C. Considerable differences occur in their expansion behavior at the higher temperatures. The average coefficient of linear thermal expansion from 20 to 1400°C for the specimens is as follows:

(*a*)	First run 6.5;	second run 5.7				
(*b*)	" " 5.0;	"	" 5.2			
(*c*)	" " 4.9*	"	" 5.5	(* range 20 to 1260°C)		
(*d*)	" " 5.4	"	" 5.3			

All values to be multiplied by 10^{-6}. R.A.H.

Heat insulations and their application in ceramic industries. E. DAMOUR AND C. ROSZAK. *La Céramique*, **31** [484], 138–43 (1928).—Fourier's theory of heat flow and

the application of the equations for homogeneous bodies to heterogeneous bodies are discussed. Variation of conductivity with temperature is pointed out. Diatomite, fossil silica, magnesium carbonate, and slag wool are discussed. The most remarkable of the recently developed insulators are cellular cement and "alfol." Cellular cement is made by mixing a potassium soap foam with a cement batch. Alfol is made from aluminium foil 0.008 mm. thick. Sheets of rumpled foil are put together so that they touch at relatively few points. The resultant product weighs only 3 kg. per cu. m. as compared with the weight of air which is 1.293 kg. per cu. m. at 0° C. The coefficient of conductivity can be as low as 0.05. The best insulator hitherto available gave a value of 0.08. The properties of a useful insulator are discussed. A long discussion follows the paper. A.E.R.W.

Effect of evolution of boilers on utilization of refractories. C. ROSZAK. *La Céramique*, **31** [485], 201–13 (1928).—I. *Refractories:* The tendency in operating boilers is to approach as nearly as possible to the "theoretical flame temperature" so as to radiate heat quickly to the surface to be heated. Refractory surfaces lose heat by (1) conduction into the wall, (2) radiation to colder surfaces. The latter effect is governed by the difference in temperature and the geometric relations of the two surfaces. A general equation governing such radiation is given. The attack by slag also increases rapidly with the temperature. The factors governing the destruction of the refractories are (1) the velocity of the burning gases, which governs the amount of cinders transported and their abrasive action, (2) the percentage of reducing gases in the hot gases, (3) the dilatation of the refractories. The refractoriness depends on chemical composition and for the usual range from 15 to 45% of alumina is highest for high alumina bricks. Other factors are the texture and the flux content. Several diagrams are given. The chemical action of the ash is determined by the relative acidity and basicity of the ash and the refractory. Texture plays an important role. Compact texture lowers refractoriness, decreases slag penetration, and lowers thermal shock resistance. In burning coal on grates with gas velocities of 12 meters per second as much as 20% of the ash in the coal may be carried to the walls; with powdered coal the percentage is much higher. The action of reducing gases is important. The expansion of the refractories depends on their composition, texture, and degree of firing. High alumina bricks have a higher but more regular expansion than siliceous bricks. II. *Evolution of hearths:* There are no refractories at the present time which have all the properties necessary for long service in the fire-place of a boiler. At 1100°C, under the action of high iron slag, silicon-carbide bricks are destroyed almost as rapidly as ordinary bricks. Attempts were made to overcome this difficulty by (1) introducing excess air, (2) recirculation of the products of combustion through the grates, (3) increasing the chamber size, and (4) circulation of cold primary air in the walls. In 1923 the development of tube walls was begun. The Murray, Bailey, Bernitz, Drake, and Füller systems are shown in diagrams. Chambers which were entirely metallic appeared later. The latest proposal is its use in the fire walls for superheating steam. Many difficulties are still to be overcome. III. *Direct heat exchange furnaces:* The theory of direct heat exchange surfaces is discussed and many types of water shield or screen are described and shown in diagrams. IV. *Comparison of direct and indirect heat exchange:* Efficiency, flexibility, and draft are discussed. V. *Conclusions:* In former times, boiler settings in which the tubes surrounded the hearth were proposed as a means of avoiding heat losses through walls which had been greatly exaggerated. Now they are used because the refractories are not available which will stand up under powdered coal firing, although early extinction of flames and incomplete combustion result. A discussion follows the paper. A.E.R.W.

Load tests at high temperatures. R. V. WIDEMANN. *La Céramique*, **31** [485], 214–25 (1928).—W. points out that while the load test at high temperatures is becoming more important the methods used in making this test have become more diversified.

It is his purpose to summarize the methods which are in use and to report some studies which were made to determine the accuracy of the method used in their laboratories and to compare the methods used in different laboratories. I. *Present methods:* The following methods are described: (1) A.S.T.M. in the U. S.; (2) in England, Mellor and Moore, modified; (3) Germany, Atom Hebel Press, Endell-Steger; (4) Germany, Tonindustrie, Hirsch-Hecht; (5) France, Bodin-Meker and Dupuy. For each method the principle of operation, recording apparatus, load, type of furnace, temperature measurement, size of specimen, deformation value, and temperatures noted are given in a table. Also diagrams and descriptions are given of the different types of apparatus. II. *C.G.C.F. method:* The Dupuy apparatus used by the C.G.C.F. (Compagnie Générale de Construction de Fours) is described in detail and its advantages and disadvantages discussed. A procedure which has been developed over a period of years is given in detail. III. *Tests of C.G.C.F. method:* A series of tests were made to determine the constancy of the apparatus, the values obtained from tests of specimens cut from different parts of a brick, the effect of a change in dimensions of the test piece, a change in load, and a change in rate of heating. IV. *Comparison of laboratories:* The following tests were made by two laboratories on the same bricks: chemical analyses load test, apparent density, true density, porosity, and after-expansion. The data obtained are compared. V. *International comparisons:* Bricks obtained from an American laboratory were subjected to load tests in (1) C.G.C. F. apparatus, (2) Tonindustrie apparatus, (3) Standard American apparatus, and (4) Endell apparatus. The values obtained are reported in a table and compared. VI. *Conclusions:* (1) For well-inverted silica bricks, the present methods give comparable results and the differences in dimensions of the specimens, the load, and the duration of the heating have no great influence; (2) for fireclay brick, however, this is not true and much work must be done before comparable results can be obtained. A bibliography and discussion follow the paper. A.E.R.W.

A simple method for determining the cohesion of refractory products at room temperature. A. JOURDAIN. *La Céramique*, **31** [485], 230–38 (1928).—J. describes a new test for cohesion at room temperature and gives a discussion of the mathematical physics of the phenomenon which underly the test. The methods used in the ordinary crushing tests or compression tests are listed and described. In the new test, 5-cm. cubes are cut from the bricks to be tested and are placed between the platens of a crushing machine with a disk of rubber about 0.5 cm. thick on either side. A hydraulic press is used. The values obtained show remarkable agreement, being usually within 5 to 6% although with the usual crushing tests a variation of 50% is not uncommon. The test is extremely sensitive, a number of brands of silica brick showing a range of values from 50 to 500 kg. per sq. cm. Unlike the usual crushing test, the specimens break sharply into several pieces and do not disintegrate or crumble. This effect accounts for the precision of the results obtained. J. shows that in the ordinary test the relation between deformation and load is indeterminate when the elastic limit for the material has been passed, and that the point of rupture depends on previous history, vibrations, etc., which we cannot control in our tests. In the new test, no crushing occurs until the point of rupture is reached, when the specimen ruptures violently. The effect of frictional resistance between the top and bottom surfaces of the specimen and the platens are first discussed in detail, experiments in which piles of sheet lead were crushed being quoted. The conclusion is reached that the radial forces due to this friction are too small to be important in the present test. By assuming that the rubber obeys Pascal's law and applying elasticity equations, J. shows that pressing a specimen between 2 sheets of rubber has the same effect as pressing it between 2 cone points, and that the maximum pressure at the center is 3 times the mean pressure calculated as the ratio between the total pressure and to total area, when resistance forces between the rubber and the

specimen are neglected. The theory also leads to the conclusion that the result is independent of the thickness of the rubber disks and the modulus of elasticity of the rubber. This conclusion has been found to be true within limits in practice. When the resistance forces between the rubber and the specimen are taken into account, a value of 1.5 times the mean pressure is secured for the maximum pressure which occurs at the center of the specimen. A.E.R.W.

Mechanical tests of refractories at high temperatures. E. L. DUPUY. *La Céramique*, **31** [485], 225–30 (1928).—D. gives a general discussion of tests of mechanical properties of refractories at high temperature and the relation between the values obtained and the service rendered in industrial installations. The following points are brought out: (1) To know how to use a refractory in the best manner it is necessary to know the relation between its mechanical resistance to deformation and temperature for the range of temperatures found in practice. (2) The object of tests is to obtain this information with the least labor. (3) Tests can be grouped into 4 categories (*a*) scientific study without an immediate technical aim, (*b*) systematic study of useful properties, (*c*) control tests for following manufacturing operations, (*d*) reception tests for verifying the clauses of a specification. D. divides refractories into two groups (1) where bond is due to recrystallization and (2) where bond is glassy. The behavior of the 2 types under load at high temperatures is then discussed. A practical illustration of the use of tests includes a description of the operating conditions found in a Cowpers regenerator. Conclusions: (1) uniformity of testing methods is desirable; (2) specifications should be drawn up only after a study of conditions, should not be unnecessarily severe, and should be the product of joint effort of consumer and producer; (3) unnecessarily stringent specifications needlessly increase the cost of production. A discussion accompanies the paper. A.E.R.W.

Domestic magnesite industry. ANON. *Eng. Min. Jour.*, **126** [11], 411 (1928).—In the caustic-calcined magnesite industry producers do not report any material increase in business as a result of the tariff increase. In an effort to increase demand for their product caustic-calcined producers have turned part of their product into the magnesite refractory field. In California one producer is operating one-half of his caustic-calcined kilns and keeps a rotary furnace fully occupied on dead-burned magnesite. A large magnesite deposit west of Luning, Nevada was discovered recently but did not excite special enthusiasm. It is understood that a company has been formed to exploit this deposit. A.J.M.

Resistance of refractories to glass corrosion. K. SILK. *Pottery Gaz.*, **53** [618], 1921–22 (1928).—Although a great many refractories are used to resist the action of molten glazes, glasses, slags, and metals, very little is known of the necessary properties in selecting a refractory to resist any one of these types of destructive influences. The biggest difficulty in the identification of certain desirable properties in refractories is that of devising a suitable testing apparatus. In the quantitative test, which should be easy, accurate, and speedy, Mellor suggests that it might be possible to automatically effect a record of the change in the apparent weight of a refractory while undergoing penetration, erosion, and solution by any particular glass or glaze, and that such a measure, obtained at different temperatures, should do much toward elucidating the fundamental physical and chemical factors involved. There might ultimately be developed a standard method of testing the resistance of refractories to molten slags and glasses. An apparatus was devised with which the data subsequently to be recorded were obtained. The work was undertaken (1) to investigate those physical and chemical factors which influence resistance by various types of refractories to molten, corrosive glasses; and (2) to determine whether the principle suggested by Mellor can be developed into a standard method of determining resistance to corrosion. Particulars of

tests with fire bricks of different compositions are given, with a view to determining (*a*) the extent of solution of the refractory by the molten glass, (*b*) the penetration of the molten glass into the pores of the brick, and (*c*) to what extent portions of the brick were undermined by solution and penetration, and the complete lifting-out of the undermined portions due to the greater density of the glass. A lead silicate glass of the most fusible type was used, obtained by the fritting of a mixture of white lead and flint in the ratio of 77.5:12. Each brick was tested at 3 temperatures for a fixed length of time: (1) 6 hours' immersion at 800°C; (2) 4 hours' immersion at 1000°C; and (3) 3 hours' immersion at 1200°C. The tests were clearly indicative of the resistance of refractories to penetration and solution by molten glass, and emphasized the fact that certain refractories may be extremely resistant to corrosion at moderate temperatures, though far less resistant at higher temperatures. With a selection of refractories such as had been included in the work described, the order of resistance to corrosion by molten glass at one temperature was not necessarily the same as the order of resistance at higher temperatures. Veined quartz appeared to be an exceedingly valuable refractory as regards resistance to solution, but this statement did not apply to converted quartz in the form of cristobalite or tridymite; the difference here was probably a physical effect due to the porosity or permeability of the converted quartz, crystal or grain. While the chemical nature of the refractory was an important factor in determining resistance to corrosion, the porosity of the product and degree of vitrification would seem to exert an effective influence on the rate of corrosion. In general, high alumina content of refractory material favored resistance to corrosion; but the physical nature of the alumina appeared to be of prime importance. When the alumina content was endued by grog of a crystalline variety (*e.g.*, a sillimanite brick) a marked resistance to solution was recorded; in fact, the results on a brick of this type adequately confirmed the view that sillimanite was valuable as a super-refractory for frit kilns, glass tank furnaces, etc. Large pores, particularly of the interconnected or laminated type, were found objectionable in refractories intended for industrial use, for resistance to glass corrosion. The rapid corrosion of highly aluminous bricks was attributed to a porosity of this variety. The recorded results left little room for doubt regarding the high resistance of the brick skin and grog to corrosion. In most cases the observed effects on the original skin were much less marked than on the other faces. In all cases the well-known and so-called "flux line corrosion" was observed at the line of contact of the brick and the surface of the molten glass. In the majority of cases, also, a very definite pitting of the under face of the test piece was recorded. These effects directed attention to the importance of density or convection currents in the glass upon the rate of solution of the refractory.

E.J.V.

North Carolina cyanite deposits. HENRY M. PAYNE. *Cement, Mill, and Quarry*, **32** [12], 75 (1928).—Forming the summit of the mountain north of Burnsville, N. C., is a large deposit of cyanite, whose outcrop begins at about 3200 ft. and extends to the apex 1300 ft. higher. The outcrop is relatively level and is in the form of an ellipse whose major axis is 6000 ft. and whose minor axis is 1200 ft. It is proposed to pass the material through primary and secondary crushers, for grinding to 40-mesh, after which magnetic separator will remove the biotite (black mica), garnets, and tourmaline and the product will then be concentrated by electrostatic separation, or by tabling and calcining, and then sacked and shipped. The material is ideal for electric porcelains, spark plugs, and similar articles subjected to great heat and vibrations. It has also been found of great value for saggers. E.P.R.

High-silica bauxite. ANON. *Cement, Mill, and Quarry*, **33** [1], 14 (1928).—Experiments in the flotation of high-silica bauxite, being conducted by the U. S. Bureau of Mines at its Southern Experiment Station, Tuscaloosa, Ala., have indicated that sodium

sulphide is the most effective reagent for conditioning the pulp. The substitution of other causticizing reagents in place of sodium sulphide usually results in a greatly increased recovery during flotation. It is significant, however, that sodium hydroxide and sodium carbonate, when used as conditioning reagents, will cause a considerable proportion of the bauxite minerals to float. Sodium carbonate is somewhat more effective than sodium hydroxide, but under the best conditions obtainable so far, neither of these reagents will yield a recovery exceeding $^2/_3$ of that obtained by using sodium sulphide.

E.P.R.

Spalling of refractories in oil-fired furnaces. ANON. *Cement, Mill, and Quarry*, **33** [2], 72 (1928).—It has been the common experience of those using fuel oil for firing boilers that the refractories of the furnaces fail because of spalling, rather than from slagging, whereas slagging is the more common trouble with furnaces fired with powdered coal. The relatively small amount of slagging in oil-fired furnaces is to be expected because the ash content of fuel oil is less than 0.1%, whereas that of the coal may be from 8 to 18%; there has been, however, no proven explanation of the common breaking up of the refractory walls by spalling, although that of strains caused by temperature variation has seemed the most reasonable one. The Boiler Furnace Refractories Investigation, which is being conducted by the A.S.M.E. has included a study of furnace conditions of two large boilers using Illinois coal and one using fuel oil. The low fusion temperature of the ash of the coals made slagging a serious cause of trouble in the coal-fired furnaces, whereas the oil-fired furnace showed the usual failures from spalling. A special comparative analysis was made of the measurements taken in the coal- and oil-fired furnaces in the attempt to elucidate the reason for the greater spalling. The rate of heat liberation in the oil-fired was much higher than in the powdered coal furnaces, but the maximum temperatures of the gases observed were the same, 2800°F. The maximum temperatures measured were somewhat higher in the oil-fired furnace at the positions where the flame impinged on the wall. The temperature gradient plotted for the first 6 in. of the hot side of the furnace wall under approximately constant operating conditions was not greater for the oil-fired than the coal-fired furnace. Rates of change in temperature of the furnace walls when the furnaces were banked or fired up were nearly the same. The rate and frequency of change of temperature during steaming were not greater in the oil-fired than in the powdered coal furnace walls; these measurements were taken at $^1/_2$ in. and farther from the hot surface. Although they do not predicate the possibility that the small temperature variations at the hot surfaces of the walls were not the same, yet there is not sufficient evidence to warrant the acceptance of change of temperature as the only cause of the greater spalling in the oil-fired furnace and differences in some other factors may be expected. Chemical composition of the ash, fuels, and slags from the walls differed materially in that those from the oil-fired stations were higher in sodium and lower in iron and calcium; the softening temperatures were low for all. Microscopic examinations of the slags have shown the presence of a mineral in the oil slag not previously found in coal-ash which has been identified as a sodium-calcium silicate. It is therefore possible that some mineral or minerals formed in the slag or in the combination of slag and brick which was sensitive to thermal shock; or the mineral may have had a much different coefficient of thermal expansion than the brick, and fracture resulted from the difference in the contraction on cooling. The relatively deep fractures found on the side and front walls bear out the former conception, and the thin fractures on the bridge walls, the latter. E.P.R.

New insulating material of metallic magnesium. ANON. *Cement, Mill, and Quarry*, **33** [2], 80 (1928).—The Westinghouse Electric and Mfg. Co. has perfected a new insulating material by a process employing metallic magnesium. E.P.R.

Chrome ore. ANON. *Refract. Jour.*, **4** [37], 2 (1928).—Although Rhodesia is the largest producer of chrome ore in the world, within a very few years, provided satis-

factory results are obtained in the direction of research work now being carried out, it should be producing on even a larger scale. It now supplies about 200,000 T. per annum, out of the worlds consumption of about 300,000 T. The greatest asbestos proposition so far discovered in the world is the Shabanie, the property of the Rhodesian and General Asbestos Corp., Ltd. The production from this particular property should gradually increase, and now that Shabanie is connected with the Rhodesian railway system by a line to Somabula, the output should increase from this one property alone to about 28,000 T. per annum. E.P.R.

Refractory materials for metallurgical furnaces. I. ALFRED B. SEARLE. *Refract. Jour.*, **4** [37], 3–6 (1928); reprinted from *Iron and Steel Ind.*—Some idea of the progress made may be gained from the fact that a few years ago electric furnaces of 3-T. capacity were considered a remarkable achievement, but today 15-T. furnaces are considered normal and electric furnaces with a capacity of 100 T. of metal are proposed. Electric furnaces are of various types, but so far as the refractory materials used in their construction are concerned, only 3 types need be considered: (*a*) arc furnaces, (*b*) resistance furnaces, and (*c*) induction furnaces. In modern arc furnaces, such as those used for making special steels, the electrodes are suspended through the roof so that the furnace merely acts as a container for the metal and various slag-producing materials, though in some arc furnaces the hearth forms one electrode, the others being suspended above it; in such furnaces, the hearth must have sufficient electrical conductivity to permit the current to flow through it to the upper electrodes and *vice versa*. The resistance type is not suitable for heating metals to more than 1000 °C. Before specifying any refractory material for an electric furnace, it is important to study the conditions; it is, for instance, impossible to find any material of sufficient refractoriness to permanently remain unaffected by direct action of an electric arc. The unusual fluidity of the molten metal and slag should also be remembered as it is the cause of much greater corrosion of the refractory lining of the furnace than occurs in furnaces which are heated by fuel. For these reasons, the refractory materials used in an electric furnace must possess in superlative degree all the good qualities essential in a fuel-fired furnace. Highly efficient circulation of metal and slag can be secured. Atmospheric control, particularly reducing atmospheres, can be obtained in electric furnaces with the greatest ease. Extremely rapid melting can be done. Prior to 1919, electric arc furnaces in which the bottom formed one electrode were not made with siliceous or fireclay linings (so-called acid linings) because such linings were regarded as nonconductive. It has been found, however, that by mixing the acid material with sufficient graphite or other good electrical conductor, this objection could be overcome. Partly on this account, but also because a basic lining can remove sulphur or phosphorus so readily from the metal, most electrical metallurgical furnaces are made with a basic bottom or hearth, the upper part of the sides being usually made of fire clay or silica bricks (sometimes with chromite bricks) and the roof almost exclusively of silica. This great difference between the composition of the roof and sides and that of the hearth sometimes leads to serious troubles as molten silica or clay dropping on to a basic hearth will soon set up a chemical action which results in a serious corrosion of the hearth. There is no question that the most urgently needed improvement in electric furnaces is a durable roof of basic or neutral material as, notwithstanding all the efforts which have been made, no perfect roof has yet been built. The ten refractory materials available for use in electric furnaces are fire clay, silica, sillimanite, bauxite, magnesite, dolomite, chromite, silicon carbide, and alundum. Graphite or carbon is the most refractory substance of all, but it cannot be used for lining metallurgical furnaces as it burns away readily and tends to impart carbon to the molten metal, so spoiling the latter. These materials may be used in the form of (1) bricks or blocks (the latter commonly termed logs); (2) powder (used for tammed or tamped linings and frequently termed ganister, even when no true ganister is present);

and (3) paste (commonly known as cement). Bricks and blocks are chiefly used for the greater part of the structure, the powdered material being restricted to forming or covering the hearth of the furnace and the cement being used almost exclusively for repairs or for coating portions to which only a paste will adhere. The essential characteristic of all bricks and blocks used in electric furnaces is that they must not shrink when in use. Their composition should depend on the position they are expected to occupy in the furnace, those on the outside may be less refractory than those forming or nearest the lining, and those used for insulation may well be of an entirely different structure and texture. Bricks and blocks which are to be exposed to sudden changes in temperature must not be made of silica or magnesia if they are expected to be durable, but fireclay bricks are not nearly so sensitive in this respect. The different types of materials employed, *i.e.*, fireclay brick, silica brick, silicon-carbide brick, etc., are discussed in detail. The refractory materials used for the hearth of an electric furnace must, obviously, depend on whether an acid or basic hearth is needed. Until recently, acid hearths were seldom used, partly because of the difficulty of making them sufficiently conductive for them to form one electrode. This difficulty has been overcome in various ways, *e.g.*, by mixing graphite with the clay prior to making it into bricks and firing under conditions which will not remove all the graphite. The deposition of carbon in the pores of the bricks after manufacture has also been found satisfactory in one case. As fire clay, silica, sillimanite, and alumina all show an increased electrical conductivity when heated, it has been found practicable to heat the furnace in any convenient manner until the lining becomes conductive and then to use it as one electrode. When an acid nonconducting lining is used, it may be made of fire clay or silica bricks, the latter being more generally used. They should be laid dry and due allowance should be made for the expansion of the silica. The empty furnace should be heated slowly until the surface of the bricks begins to melt, after which a lining of ground ganister is usually desirable. Fire clay and silica bricks are specially suitable for electrically-heated annealing furnaces. Fire clay is superior to silica for this work as it is less sensitive to sudden changes in temperature. As fire clay shrinks considerably when heated, it is of the greatest importance that the blocks or bricks should be heated to a temperature distinctly higher than they are likely to experience when in use, otherwise the lining may shrink and fall out. If a more durable acid lining could be found for electric furnaces, it would be a great advantage. Possibly, the extended use of sillimanite or of an intimate mixture of fire clay and bauxite having the same composition may serve the desired purpose. Carbon bricks may be used for ferro-alloy and vanadium, but cannot be used for steel furnaces, as the metal would absorb carbon irregularly and would consequently be spoiled. E.P.R.

Permeability of masonry in open-hearth furnaces. ANON. *Refract. Jour.*, **4** [37], 6 (1928); *Arch. Eisenhüttenwesen*, No. 11 (1928).—The results have recently been published, as a communication of the Steel Works Committee of the German Iron and Steel Works Assn., of work carried out by Hugo Bansen on the gas permeability of silica brick, mortar joints, and masonry work in open-hearth furnaces. Elaborate tests showed that the gas permeability of masonry work is mainly due to cracks or fissures in the mortar joints. Special care should accordingly be given to the drying of these latter in order to avoid as much as possible the cracks resulting from rapid drying. Joints formed from ground faces without the use of mortar were of no advantage, the perviousness being three times as great as with masonry having mortar joints. In the case of thin-walled flues of recuperators, the gas permeability of the bricks and mortar joints is, in contrast with the thick-walled chambers of the open-hearth furnace itself, of not inconsiderable influence on the losses. E.P.R.

Chromite in Central Anatolia. ANON. *Refract. Jour.*, **4** [37], 17 (1928).—A Swedish consortium has applied for a government concession to exploit the deposits of chrome

ore near Eski-Shehir and other localities in the same neighborhood. The ore is reported to carry from 43 to 50% of metal. Some of the ore bodies are close to the Anatolian railway, and will be less costly to transport than the ores mined by the Rochling concern, near Dagh Ardy, which has to be carried on donkeys and carts. E.P.R.

University of Sheffield Chemical Society. ANON. *Refract. Jour.*, **4** [37], 34 (1928).—At a meeting of this Society held Oct. 12, a paper on the "Manufacture of Silica Bricks" was read. The paper deals with the types of raw materials used and the general methods adopted in modern practice in the making of high-grade silica refractories. The physical and chemical changes which take place during the firing of the bricks are discussed in detail. E.P.R.

PATENTS

Process for the manufacture of sulphate of aluminum. LOUIS GABRIEL PATROUILLEAU. U. S. 1,692,692, Nov. 20, 1928. Process for obtaining an insoluble sulphate of aluminum from bauxite, consisting in subjecting the bauxite to the action of sulphuric acid to reduce the bauxite to a solution of multiple sulphates, transforming the salts of iron contained therein to soluble ferrous salts through the addition of iron and the action of heat, diluting the resultant so as to precipitate the basic sulphate of aluminum, and recovering the insoluble sulphate of aluminum.

Process of and apparatus for making clay articles. ELBRIDGE J. CASSELMAN. U. S. 1,692,887, Nov. 27, 1928. The process of making clay articles, which comprises confining a clay slip so as to define an article of the desired size and shape, materially retarding absorption of water from at least some of the faces of the formed article, permitting absorption of water from one face thereof, and varying the pressure on the slip.

Pot furnace. ALBERT J. HANSON. U. S. 1,694,416, Dec. 11, 1928. In combination, a furnace having a pot-receiving opening, a pot in the opening having an upper marginal portion extending outwardly in position to overlie a portion of the furnace, and an annular furnace plate engaging over the marginal portion and extending below its upper edge.

Sintered magnesite brick and method of making. KARL HARR. U. S. 1,694,540, Dec. 11, 1928. The method of producing sintered magnesite refractory material, which comprises mixing relatively pure natural magnesite with aniline oil residues and sintering the mixture.

Impervious material. WARREN F. BLEECKER. U. S. 1,694,730, Dec. 11, 1928. An article of manufacture consisting of a solid body of artificial graphite, the voids of which are closed with sulphur.

Bonded refractory. RUSSELL EDMUND LOWE. U. S. 1,694,924, Dec. 11, 1928. An article of manufacture comprising a graded refractory aggregate bonded by less than 1% of a highly adherent bond formed by the chemical precipitation of a hydrate in intimate adhering contact with the particles of the aggregate, and substantially free from other substances formed at the time of precipitating the material.

Terra Cotta

Terra cotta kiln slab investigation. R. L. CLARE, G. H. BROWN, AND F. B. ALLEN. *Jour. Amer. Ceram. Soc.*, **12** [1], 62–68 (1929).—Following several discussions as to the constitution of a good kiln slab for terra cotta manufacture, a coöperative test was made in which slabs of various compositions were manufactured by a producer of refractories, tested under actual service conditions, and physical measurements were determined by the Ceramic Dept., Rutgers Univ. Series included the use of tight firing medium refractory clays, open firing refractory clays with grog, both vitreous and porous. Grogs were sized (definite proportions of size ranges constituting the different members). Conclusions were drawn as to effect of all these variables.

Manufacture of clay roofing tile in France, Belgium, and Holland. W. A. McINTYRE AND A. ZAIMAN. *Pottery Gaz.*, **53** [618], 1929 (1928).—The clays used range from a soft surface clay to a hard underground clay or shale, and may be of any geological age from the Quaternary down to the Carboniferous. Deposits of an earlier age to not appear to be used for tilemaking. The clay is almost invariably hand dug and loaded on to wagons or lorries. The transport of the material is an important item in many Continental clayfields. In England the location of the factories appears to have been governed solely by proximity to the clay but on the Continent the deciding factor is the ease of transport of fuel and finished products. In some cases both factors have been considered. Weathering is less practiced in the Continental works visited than it is in England. Apart from "lacing" and the addition of barium carbonate, the mixing processes differ in no important respect from those usually adopted in England. In general, the Continental manufacturers seem to pay considerably more attention to pugging and regrinding than do the English makers. The sowing process is not used to any great extent on the Continent. For pressing, many of the works employ a revolving press of the "Marseilles" type, consisting of a pentagonal drum with 5 molds which descend upon a base plate. The molds are all made of plaster, usually extra finely ground, without the addition of any indurating material, and have a life of about 6 hours for the drum molds and one hour for the base. Some of the machines are arranged to give an upper as well as a lower pressing, and the duration of the pressing varies with the consistency of the batch. A variety of drying systems is in use, but two features are common to nearly all of them: (1) they are 3 or 4 stories high, mostly with open spaced floors and ventilated ridges, giving a good circulation and some degree of control, and (2) they utilize waste heat from the kilns to a greater or less extent. The various drying systems form a great contrast to those in England, where drying is mostly carried out in long one-story sheds on racks, which may be artificially heated, or on steam-heated floors, and where the ventilation is extremely bad. The almost universal use of intermittent kilns in England is against the use of long drying sheds over the kilns, but, on the other hand, there is much waste heat which could be utilized. The use of continuous kilns for firing ordinary red tiles is universal in the works visited, the only intermittent kilns seen being for a very small output of a special type of ware. The contrast between Continental and English practice in this respect is most marked. As mentioned previously, the great majority of English manufacturers use intermittent kilns, in which the greater part of the heat escapes by radiation from the walls and through the stack, and practically no attempt is made to utilize this heat in any way. E.J.V.

Suspension of terra cotta glazes. P. W. LEE. *Pottery Gaz.*, **53** [618], 1952–53 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [9], 713–14 (1928); see also *Ceram. Abs.*, **7** [10], 697 (1928). E.J.V.

Special brick lines; acid proof bricks and bonds. ANON. *Brit. Clayworker*, **37** [439], 296–98 (1928).—The term "acid-proof brick" is confined to bricks which are acid-proof under the ordinary conditions of use and to ordinary commercial acids excluding hydrofluoric. Resistance to acid is a property which depends on several others, of which the most important are: (1) insolubility in a specified acid; (2) a minimum surface exposed to the action of the acid; (3) uniformity in composition, so that if the original surface is worn away by abrasion, the remainder of the brick will still be acid-proof; and (4) a suitable bond. In the absence of any one of these properties, no brickwork will be acid proof. Insolubility in the specified acid depends chiefly on the use of a clay or silica rock which is of sufficient purity not to yield any soluble matter to the acid. Most fire clays, ball clay, china clay, and many stoneware clays are suitable in this respect. A minimum surface exposed to the action of the acid is important. The greater the volume of open pores the greater will be the area of brick material exposed to

the action of the acid. A porous brick may expose 15 to 50 times its apparent surface to action of the acid. Such clays as do not contain sufficient fusible material to fill all the pores during firing to obtain the desired porosity must be mixed with either a flux or a fusible material. The chief characteristics of good acid-proof bricks are accurate size and shape with clean arrises and sharp corners, a smooth surface, and a fine, close, and wholly impervious texture. The bricks should be laid in a very lean mixture of sand and Portland cement, the joints raked out and pointed with hot bitumen, or much better, laid in hot bitumen. Few "powder cements" are sufficiently acid proof for use with acid-proof bricks and all ordinary mortars are useless. R.A.H.

Equitable Trust Company building, New York. ANON. *Arch. and Bldg.*, **60** [4], 105–106 (1928).—For the exterior, the base stories are of granite, the walls above of light brick and limestone with the building topped out with a pyramid of limestone. Though the vertical lines of the design tend to intensify the height, the mass of the structure is its impressive feature and the bold outline of the surmounting pyramid forms a notable addition to New York's skyline. E.P.R.

Hotel Lincoln, New York City. ANON. *Arch. and Bldg.*, **60** [3], 71 (1928).—The exterior of the building is of buff brick with terra cotta trim and limestone in the lower stories developed in a simple design with Italian feeling. Straight lines and an emphasis of brilliant coloring with striking decorative notes characterize the interior. Lighting fixtures play an important part in the effects. The materials used consist of marble, Kasota stone, Travertine, bronze, and wrought iron work, all harmoniously related. E.P.R.

BOOKS

Essence of Architecture. WILLIAM ROGER GREELEY. D. Van Nostrand Co., Inc., New York. 134 pp., 49 figures. Price $2.50. Reviewed in *Arch. and Bldg.*, **60** [4], 136 (1928).—The essay expresses G.'s views on architectural beauty. E.P.R.

Architectural Details. FRANK HALSTEAD. John Wiley & Sons., Inc., New York. 292 pp., 114 plates. Price $3.50. Reviewed in *Arch. and Bldg.*, **60** [4], 136 (1928).—The book is a treatise on architectural drawing for the use of trade and vocational schools, for architectural draftsmen and builders. The first chapter is on windows and is illustrated with 37 plates; other chapters are on doors, cornices, etc. Seven plates are of fireplaces and chimneys, showing layout of flues, construction of fireplaces, and the framing about them. The book is a companion to "Architects' and Builders' Reference Book." E.P.R.

Orders of Architecture. FRANK HALSTEAD. John Wiley & Sons, Inc., New York. 148 pp., 45 plates. Price $3.00. Reviewed in *Arch. and Bldg.*, **60** [4], 136 (1928).—The book gives the orders of architecture and includes a discussion of classic moldings, column construction, and other details. It is a companion to "Architectural Details" and "Architects' and Builders' Reference Book." E.P.R.

Architects' and Builders' Reference Book. FRANK HALSTEAD. John Wiley & Sons, Inc., New York. 200 pp., 67 plates. Price $3.00. Reviewed in *Arch. and Bldg.*, **60** [4], 136 (1928).—The aim of the book is to present those subjects of fundamental importance in the study of architecture which a student does not obtain until actually working in a drafting room. The subjects follow the sequence of construction: excavation, foundation, stonework masonry walls, etc. E.P.R.

White Wares

Rate of oxidation of porcelain and ball clays. HOBERT M. KRANER AND E. H. FRITZ. *Jour. Amer. Ceram. Soc.*, **12** [1], 1–13 (1929).—In this study the rate of CO_2 evolution was determined by passing a 4% oxygen-96% nitrogen gas mixture over a bar of clay or porcelain while this bar was being heated at an approximate rate obtained

in the ceramic kilns. The water and CO_2 evolved were collected in phosphorous pentoxide and soda lime, respectively, and the respective apparatus weighed each half hour during the length of the run. It was found that oxidation took place rapidly between 200°C and 550°C in both clay and porcelain. This is much different from what has been generally understood to be true, for in all the ceramic literature, 750°C seems to be indicated as the most efficient temperature at which oxidation proceeds. It appears that oxidation of ceramic ware such as these can take place at much lower temperatures and with much greater economy in firing practice.

Insulation in the ceramic industry. E. A. PHOENIX. *Jour. Amer. Ceram. Soc.*, **12** [1], 48–55 (1929).—The following subjects are discussed: (1) heat losses in ceramic kilns, (2) early attempts at reducing heat losses from kilns, (3) properties of an ideal insulation for kilns, (4) advantages of kiln insulation, and (5) various applications of heat insulating material in the glass plant.

Abrasive hardness of flooring materials. ANON. Bur. Stand., *Tech. News Bull.*, **139,** 159–60 (1928).—A study has been undertaken of the abrasive hardness of certain stones, such as are commonly used for flooring in the more permanent construction. Actual wear measurements on 33 samples are compared with results as obtained with a specially developed testing device. The comparisons indicate that some materials may wear at a somewhat different rate under the conditions of actual service than is indicated by the testing apparatus, but in general the information gained from the tests appears to be of considerable value. A description of the apparatus is given. The following range values obtained in the tests completed show the hardness of different materials: Verde antique marbles 78 to 104, siliceous marbles 25 to 35, calcite and dolomitic marbles 7 to 25, crystalline limestones 15 to 20, oolitic limestone 4 to 12, slates 7 to 12. R.A.H.

Insulator molding room and molding of porcelain insulators. C. DORNEDDEN. *Sprechsaal*, **61** [27], 523–25; [28], 541–44; [29], 559–61; [30], 579–81; [31], 597–99; [32], 617–20 (1928).—The author stresses the necessity of systematic working plans to obtain maximum efficiency in making insulators. Sketches with dimensions of an ideal molding room and an individual work bench layout are shown in cross-section. A ground plan (elevation) is included. The advantages and disadvantages of various types of jiggering machines are discussed and numerous types of machines are illustrated. A description with sketches is given of the various shapers, tools, lathes, etc., used in the preparation of porcelain insulators. R.A.H.

Increasing production in mosaic tile industry. OTTO KAUFFMANN. *Ber. deut. keram. Ges.*, **9** [9], 501–506 (1928).—Time saving devices and methods in the following departments of a mosaic tile plant are discussed: (1) body preparation department, (2) the department in charge of the transportation of unfired ware, (3) the firing and sorting department. F.P.H.

Defects in sanitary ware eliminated by efficient slip house practice. PAUL TEETOR. *Ceram. Ind.*, **11** [6], 605–606 (1928).—The two properties of a casting slip ordinarily measured are the specific gravity and the viscosity. Of these two the viscosity measurement is the most important. The correct viscosity for any slip must be determined by correlating the viscosity with the casting properties in the casting shop and with the kiln losses. After the proper viscosity has been determined, slip with desirable casting properties can then be produced by maintaining constant viscosity and specific gravity. Any change in the raw materials will nearly always demand a change of viscosity. Likewise a change of several degrees in the temperature will affect the viscosity. Ordinarily it is necessary to prepare slip with a lower viscosity during the summer months than during winter months. The ideal temperature is 70 to 80°F. Casting slip can also be prepared direct from the raw materials and thus eliminate the operations of

filter-pressing and reblunging. This method has the advantage of costing less to produce, but it has the disadvantage of producing a dirty body because the viscous slip renders screening through a 120-mesh lawn practically impossible and also greatly reduces the effectiveness of even the most powerful electro-magnet to remove particles of magnetic iron. During the entire process of slip preparation and distribution it is necessary to take every possible precaution to prevent aeration of the slip and pinholed ware. The tendency of a slip to produce pinholes can be ascertained by determining the increase in volume of the slip when placed in a vacuum within $^1/_2$ in. of the barometric reading. If the increase in volume is less than 10%, the slip will not produce pinholes. F.P.H.

Prevent defects in body composition by slip method. KENNETH SMITH. *Ceram. Ind.*, **11** [6], 607–608 (1928).—Body mixing by the slip method is described. F.P.H.

Laboratory control tests for ceramic plants. F. A. KIRKPATRICK. *Ceram. Ind.*, **11** [6], 609–10 (1928).—An example of an efficient control test system is described in detail. This system is in operation at a plant whose products are sanitary ware made of porcelain body by the casting method. All raw materials are tested when received, the clays for moisture, shrinkage, absorption, and color, and the feldspar and flint for size of grain and firing behavior. The materials are proportioned on a dry basis. Moisture determinations of the clays are made daily and the scale beams are set to weigh enough wet clay to give the desired amount of dry material. The casting slip is made by grinding the materials in ball mills, from which it is pumped into storage tanks. The slip is poured into two test molds which are kept in condition by resting on top of a laboratory drier. After a chosen length of time (about one hour) the excess clay is struck off and the cast pieces are subjected to a deformation test. A 500-g. iron cylinder held in a guide is allowed to fall onto the test piece three times from a height of two inches. The ratio of thickness after impact to that before impact is determined for six specimens and gives an arbitrary plasticity figure, useful in connection with the casting process. After laboratory tests are completed, the slip in the storage tanks is treated (if found necessary) by addition of water, sodium silicate, or soda ash. Excess of these constituents is avoided by using deficient amounts in preparing the slip in the mills. Specific gravity of the slip is maintained above 1.80, and the time of flow between 60 and 70 seconds. A definite relation is seen between these properties and the optimum casting conditions of the slip. The casting behavior is predicted also by the deformation test, whereby the degree of "hardness" of the cast ware can be foretold. Before this test was devised, daily complaints came from the casters that the slip cast "hard" or "soft." The condition of the molds is found to be the cause of complaint. F.P.H.

Ivory porcelain bodies. ANON. *Ceram. Ind.*, **11** [6], 611 (1928).—The best type of ivory procelain can be obtained in an oxidizing fire at a high temperature, and the body should contain no more than a total of 2 to 3% iron oxide. If the color of the body is too weak, the addition of 0.5 to 1.0 part of rutile will help. Fire to cone 7 to 10 for best results. A reducing fire will give a gray tone. Parian toned ware can be made of a mixture of feldspar 63, china clay 37. It is quite simple to obtain the ivory color by means of a colored glaze, but it must be applied very carefully so that the glaze will be of practically the same thickness over the entire piece. The cheapest and simplest method of producing an ivory is by employing a buff firing clay with 2 to 3 parts of iron oxide added to the body or the same amount of rutile. It is sometimes possible to obtain a good color by means of adding 2 parts of manganese to 98 of body. When this is used it is best to mix a portion of the body with the color for a while in a mixer, then add the rest of the body for further mixing before it goes to the plunger or ball mill. A good ivory can be had by adding 5 parts of zirconium oxide. F.P.H.

Quality of dinnerware improved by preventing defects in the clay state. THOMAS PLACE. *Ceram. Ind.*, **11** [6], 612–14 (1928).—The control of body composition and control of operation in the clay state are two of the most important factors in quantity production of quality dinnerware. The control of body composition is the function of a good laboratory. In the wide field of clays and materials available for this type of ware, there will be found individual clays and combinations of clays and materials which may be manipulated in body composition to meet practically any operating condition that may arise. In the actual preparation of a body, every precaution is necessary in order to maintain as nearly uniform composition and condition as is possible. The moisture variation in different shipments of clay and different soaks must be compensated for. The weighing out of batches must be carefully supervised. The large variation that does occur in these two things is too often disregarded. The magnetic separator requires continual attention and check up. The magnets must be maintained as strong as possible, cleaned frequently to prevent too much accumulation of iron which may be washed off by the speed of the slip flowing through the troughs, and the pump or by-pass must be adjusted so that the slip does not flow too deep over the magnets. There is continual wear on the screen or lawn. An analysis of the slip passing the screen should determine the number of allowable hours of operation of the screen. No screen or lawn should be run more than two days before it is taken off, dried, cleaned, and inspected for small breaks and weak spots. In the selection of a screen, a strong magnifying glass will show considerable variation in the smoothness of the wire and uniformity of the weave in different makes of screen cloth, seriously affecting the efficiency of the screen. F.P.H.

Avoiding defects in dry process. ANON. *Ceram. Ind.*, **11** [6], 616–18 (1928).—In the production of dry-process porcelain there are many apparently minor details which have weighty influence over subsequent results throughout the plant. First of all one can, by a little care, increase the dry strength of the porcelain to a marked degree by watching slip gravities. An increase in strength of a porcelain body of as much as 20% can be obtained by merely raising the gravity of the body slip about an ounce to the pint. By the use of slips of higher gravity (21½ ounces per pint and more depending upon the clays and the clay content) much plastic and nonplastic separation is eliminated and a slight reduction in die wear will be noticed in the press shop. In addition a reduction in filter pressing time will be obtained, in some cases this time saving being as much as 40 to 50 minutes per round. This is the equivalent of added slip house capacity with no additional financial outlay. F.P.H.

Czechoslovakian porcelain industry during the first ten years of the republic. ANTON ZEBISCH. *Keramos*, **7** [20], Ma (1928). F.P.H.

High quality ceramic insulators. F. A. FORSTER. *Keramos*, **7** [21], T3 (1928).—The development of the present-day high tension insulators is traced. The development and properties of steatite insulators are discussed. F.P.H.

Classification of whiteware for shipment to U. S. ANON. *Keramos*, **7** [24], Ma (1928).—The classification of whiteware and the tariff on the various classes of whiteware intended for shipment to the U. S. are discussed. F.P.H.

Doulton potteries. ANON. *Pottery Gaz.*, **53** [618], 1924–29 (1928).—A brief historical and descriptive sketch regarding the section of the Doulton potteries situated at Burslem, Stoke-on-Trent. The article is well illustrated by photographs taken during the visit. E.J.V.

Pottery in Scotland. ANON. *Pottery Gaz.*, **53** [618], 1940–42 (1928).—A description of the plant of the Britannia Pottery Co., Ltd., at St. Rollox, near Glasgow. The company has a new body called "Scotch ivory" besides several standard bodies. E.J.V.

Exhibits at Leipzig Fair. ANON. *Pottery Gaz.*, **53** [618], 1942 (1928).—The German

porcelain industry conducted a prominent advertising campaign at Leipzig during the fair. All over the city, throughout the week, large posters requested the public to "collect more porcelain." In the largest square in Leipzig one firm erected a shop in the form of a soup tureen, and another exhibited a huge coffee pot. Another erected a tower, the main part of which was faced by porcelain cups. A guessing contest was conducted on the number of cups used in the construction of the tower. It was illuminated at night. E.J.V.

China bodies of the Belleek type. P. F. COLLINS. *Pottery Gaz.*, **53** [618], 1945–46 (1928); reprinted from *Jour. Amer. Ceram. Soc.*, **11** [9], 706–12 (1928); see also *Ceram. Abs.*, **7** [10], 699 (1928). E.J.V.

Vacuum treatment of clay slips and bodies. H. M. KRANER AND A. H. FESSLER. *Pottery Gaz.*, **53** [618], 1952 (1928); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [10], 725–29 (1928); see also *Ceram. Abs.*, **7** [11], 769 (1928). E.J.V.

Vapor absorption of a fired earthenware body. C. L. DEEDS. *Pottery Gaz.*, **53** [618], 1952 (1928); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [10], 769–70 (1928); see also *Ceram. Abs.*, **7** [11], 769 (1928). E.J.V.

Structural research on hard porcelain. O. KRAUSE. *Z. tech. Physik*, **9**, 247–63 (1928).—For the manufacture of hard porcelain are used: (1) "clay" substance (or kaolinite) $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$, which is plastic and loses H_2O and decomposes from 300° up, forming more HCl-soluble Al_2O_3; at 800° this decomposition is finished; at 1200° and above a new compound seems to be formed; a time heating curve shows at 570° an endothermic, at 950° an exothermic effect; (2) quartz, with the α-β (575°) transformation and those of tridymite and cristobalite, (3) feldspar, consisting mostly of orthoclase and a little albite, the former melting at 1200° and partly transforming into crystalline leucite melting at 1100°. From these data, characteristics of porcelain (average 50% 1, 25% 2, 25% 3) can be derived. The end product is in the heterogeneous system Al_2O_3–SiO_2–K_2O (or Na_2O). Complete bonding of Al_2O_3 and K_2O can be assumed with up to 20% free SiO_2. Heterogeneous equilibrium is only partly reached. The composition attained is probably parallel to the Al_2O_3–SiO_2 side of the triangular diagram and the substance will have a fusing curve similar to that of Al_2O_3–SiO_2, allowing for a depressing influence of the alkali. It is therefore to be expected that ideal porcelain is a glassy mass with crystallites of mullite ($3Al_2O_3 \cdot 2SiO_2$) and tridymite. These views were tested by X-ray work. Samples, finely pulverized, were illuminated with CuKα light (4 to 5 hrs.), the results being calculated by Braggs relation. Experiments on kaolin (SiO_2 45.34%, Al_2O_3 37.93%, ignition loss at 1000° 13.92%) showed that this substance dried at 200° giving a diagram identical with that of natural nakrite (Freiberg); on heating at higher temperatures more and more lines disappear. At 600° the original lattice is practically gone (no macroscopic change), leaving only a few of the strongest lines (amorphous). A second change appears at 1000°, showing recrystalline and mullite formation, proportional to the kaolinite content. To confirm this point the crystal needles from a kaolin melt were compared with natural (Delaware Co., Pa.) sillimanite ($Al_2O_3 \cdot SiO_2$). The similarity is incomplete; the reflection angles of "mullite" are on the average 0.15° smaller than those of sillimanite (more than the limit of error) and always equal to those found for the needles in porcelain (one exception, unexplained, of sillimanite needles was found in an a. c. spark plug porcelain). Conclusion: The crystals formed on firing of ceramic masses are silicates with a lattice distorted (widened) by added Al_2O_3, it may be called mullite. X-ray pictures of fired porcelain (German and American) showed mullite to be present in all to a greater extent than previously assumed. Three groups of porcelain are distinguished: (1) poor in mullite, rich in quartz; (2) average in both; (3) rich in mullite, poor in quartz. The mechanically strong porcelains (motor insulators, power line insulators) seem to belong

to group 1. The second group is of average quality; the 3rd group is that of the farthest advanced equilibrium (Staatliche Porzellan Manufaktur) and shows the best resistance against temperature changes. The Gilchrest and Klinefelter criteria for electrical thermal and mechanical resistance as related to composition (*Electric Jour.*, **36**, 77 (1918)), were confirmed. Diagrams are shown of porcelain mass fired to various temperatures from 625 to 1410° in which the gradual disappearance of feldspar and quartz, and the appearance of tridymite and mullite can be traced. Rieke's work on this subject is discussed. For the formation of the mullite crystals it is assumed that submicroscopic crystals are formed below the formation point of the liquid phase. On further heating they partly dissolve in the latter and later on separate out after saturation of the melt with SiO_2. (*C.A.*)

PATENTS

Insulator structure. WILLIAM K. NAYLOR. U. S. 17,150, Dec. 4, 1928. (Reissue.) (1) An insulator of the pin-type comprising an insulating member having a recess, and a pin cemented in position in the recess having a galvanized portion and a portion of different character for holding coöperation with the cement. (2) An insulator comprising an insulating member and a member coöperating therewith, one of the members having a recess and the other having a portion bonded in position in the recess and the coöperating member having only its exposed surface provided with a weather-protective coating.

Terminal for bushings. ARTHUR O. AUSTIN. U. S. 1,691,327, Nov. 13, 1928. (1) In combination a dielectric bushing, a conductor rod extending through the bushing, means connected with the rod for engaging the inner end of the bushing for limiting the outward movement of the rod, means removably connected with the outer end of the rod for holding the end of the rod against movement into the bushing, means for preventing rotation of the rod in the bushing, and a closure member threaded onto the rod at the outer end thereof and having a bearing portion registering with the bushing and exerting an outward tension on the rod. (2) In combination a dielectric bushing, a conductor rod extending through the bushing, a stop at the inner end of the rod for limiting outward movement thereof, a spring washer interposed between the stop and bushing, and means on the washer coöperating with the conductor and bushing for preventing rotation of the rod relative to the bushing.

Terminal for insulator bushings. ARTHUR O. AUSTIN. U. S. 1,691,328, Nov. 13, 1928. A fitting for an insulator bushing comprising a cap arranged to cover the end of a bushing and having a flange of less diameter than the cap extending upwardly from the top thereof, the flange having an opening therethrough, a conductor extending through the opening and having a portion of the end thereof projecting beyond the flange, the projecting portion being slitted to provide resilient tongues, and a cover cap threaded upon the exterior of the flange and providing an imperforate closure for an opening through the flange, the cover cap having a tapered boss extending toward the end of the conductor and arranged to enter between the tongues to force the tongues outwardly against the inner face of the flange.

Insulator. ARTHUR O. AUSTIN. U. S. 1,691,330, Nov. 13, 1928. The combination with a series string of detachably connected insulators, each having an upper approximately cylindrical restricted portion and a radially projecting flange of supplemental flanges of dielectric material, each having a diameter greater than the maximum diameter of the insulators, one of the supplemental flanges having an opening therethrough of a size to receive the upper restricted portion of one of the insulators, to permit the supplemental flange to rest on the flange of the insulator and support the supplemental flange on the insulator, the supplemental flange being carried on the uppermost insulator of the string and having a reinforcement extending about the periphery

of the opening therethrough, another of the supplemental flanges being carried on an insulator between the ends of the string, the intervening insulators of the string being without supplemental flanges.

Insulated control. ARTHUR O. AUSTIN. U. S. 1,691,751, Nov. 13, 1928. (1) An insulator comprising a dielectric member, an electrode, and means providing separate paths of discharge from the electrode, the paths being arranged adjacent one another so that the discharge along one path will be diminished by the influence of the discharge in an adjacent path. (2) An insulator comprising an electrode, a dielectric member connected with the electrode and having the upper surface thereof extending laterally from the electrode and ribs on the surface arranged to form separate over-lapping paths of discharge from the electrode, the lowermost portions of the paths being open to provide drainage. (3) An insulator having a dielectric barrier thereon provided with a drainage passage, the passage being shielded by a charged surface, one end of the passage being open adjacent the surface and having direct connection therewith.

Insulator-locking device. RAY S. DICKEY AND PAUL A. CARNAHAN. U. S. 1,691,964, Nov. 20, 1928. The combination with an insulator supporting pin having a slot and a bore communicating therewith, of an insulator having threads, a locking key having an end arranged to enter the bore, the opposite end being arranged to enter one of the threads of the insulator, a portion of the key between the ends serving as a fulcrum, and a portion of the key being arranged to be engaged by the threads of the insulator to rock the key on its fulcrum.

Screen-feeding means for tile-cleaning machines. HARRY D. LILLIBRIDGE. U. S. 1,692,556, Nov. 20, 1928. A tile cleaning machine embodying a rotary separating cylinder, the receiving end of which is reduced in diameter, a cylindrical band concentric with the cylinder, the band extending into the cylinder inwardly from the reduced end thereof, the cylindrical band and the reduced cylinder end partially closing the receiving end of the cylinder and the band affording an inlet for material, and an endless conveyer, the discharge end portion of which is projected beyond the cylindrical band, the discharge end of the conveyer being located slightly above the level of the lower portion of the band and the discharge end being enveloped by the cylindrical band and by the cylinder.

Ceramic-glazing process. WILLIS O. PROUTY. U. S. 1,693,252, Nov. 27, 1928. In a process of forming glazed ceramic products having a surface of variegated color, the operation of applying to the bisque a coating of glaze mixture of selected color, applying over the first coating a coating of glaze mixture of a different color and containing an insoluble material that will be eliminated in the firing of the glaze, spraying a third coating of glaze mixture over the second coating and firing the product so prepared.

Insulator. GEORGE I. GILCHREST. U. S. 1,693,380, Nov. 27, 1928. (1) In an insulator, the combination with a pair of insulating members each having a portion entirely thereacross of insulation and embodying a cylindrical portion having a flat transverse end surface disposed in close proximity to the flat-end surface of the other, of a metal member secured to each of the ends embodying a transverse discoidal portion in relatively close flat-surface relation to its insulating member and contacting with the metal member of the other insulating member, each metal member having a uniform relatively smooth outermost perimeter and a central portion for connection to the other, one of the central portions being disposed within the plane of the outer surface of its discoidal portion. (2) An insulator comprising an insulating member having a recessed cylindrical end and a metal terminal member having a discoidal portion disposed in flat transverse relation to the longitudinal axis of the insulator over the end and cylindrical longitudinal flanges, one of which embraces and is secured to the end and the other of which, constituting a holding portion for attaching the

insulator to an exterior member, extends into the recess. (3) An insulator comprising an insulating member having cylindrical ends, one of which is recessed, a metal terminal member having a discoidal portion disposed in flat, transverse relation to the longitudinal axis of the insulator over the recessed end thereof and cylindrical longitudinal flanges, one of which embraces and is secured to the recessed end and the other of which is internally screw threaded and extends into the recess, and a similar terminal member having a discoidal portion in flat, transverse position over the other end of the insulating member and cylindrical longitudinal flanges, one of which embraces and is secured to the other end of the insulating member and the other of which is externally screw-threaded and projects outwardly from the insulating member, the terminal members each having an annular raised seat portion on the outer surface thereof intermediate the flanges thereon.

Insulator. GEORGE I. GILCHREST. U. S. 1,693,381, Nov. 27, 1928. (1) An insulator comprising a pair of insulating members having adjacent end portions, one of which has a central recess therein, a terminal member having a central portion extending into the recess and secured in position over the recessed end portion, the inwardly-extending portion embodying a connector seat portion inside the recess, and a second terminal member having a central projecting connector portion for coöperation with the seat portion and secured in position over the adjacent end portion of the other insulating member, the terminal members having adjacent surfaces of relatively great areas spaced in substantially equidistant relation to each other throughout when the axes of the insulating members are in alignment. (2) In an insulator, the combination with an insulating member having an opening therein, of a connector therefor comprising two members, one of which has an elongated slot and a channel portion extending transversely with respect to the slot, and the other of which has a projection and a transverse elongated head on the projection for insertion through the slot and for positioning in the channel, the head and the channel being operatively positioned inside the opening in the insulating member. (3) An insulator connector comprising two relatively thin discoidal members disposed in proximate substantially parallel planes, one of the members having an elongated slot and a channel portion on one side extending transversely with respect to the slot, and the other members having a projection and a transverse elongated head on the projection curved at its under side for insertion through the slot and for rocking positioning the channel.

Insulator. CHESTER S. GORDON. U. S. 1,694,415, Dec. 11, 1928. An insulator comprising a body of dielectric material having an internal screw threaded opening downwardly extending from the top into which a downwardly extending supporting pin may be screwed, a caplike member of dielectric material arranged to be secured to the lower end of the body to from a shoulder above which the line conductor and tie wire may be secured, and a member extending outwardly and downwardly from the body to prevent moisture from being deposited on the shoulder, the shell of the body between the shoulder and the member being of substantially uniform thickness.

Method of molding ceramic materials. DONALD W. ROSS AND JAMES M. LAMBIE. U. S. 1,694,563, Dec. 11, 1928. Method which comprises introducing deflocculated plastic ceramic material into a mold and simultaneously vibrating the material.

Machine for forming plastic tile. HOLDEN BROCK. U. S. 1,694,579, Dec. 11, 1928. In a machine of the class described the combination of a conveyer, a normally open bottomed receptacle, palettes supported by the conveyer to form a bottom for the receptacle, a packer, a dam, a trowel, and a perforating device.

Tile. EUGENE PARKER. U. S. 1,694,665, Dec. 11, 1928. Hexagonal tile having integral interfitting and spacing lugs along the edges thereof, the interfitting lugs

being spaced alternately for juxtaposed tiles, the interfitting lugs also adapted to be completely surrounded by mortar when the tiles are laid.

Dishes. H. HAPPY BERRY. Brit. 296,544, Oct. 31, 1928. A dish is formed with one side in the form of an ordinary plate and the other side so shaped that in the inverted position of the dish it is usable as a carving dish and for this purpose is provided with an upstanding annular flange comprising a series of projecting parts. The dish either rests on the extreme peripheral edge or the flange according to which side of the dish is being used. A gray-collecting groove may be provided within the flange or surrounding the same.

Casting porcelain articles. KUNSTZAHN GES. Brit. 296,765, Oct. 31, 1928. A raw material for use in casting porcelain articles such as artificial teeth or fillings for teeth, consists of porcelain grains of substantially spherical or pea-like form, such grains being produced by casting a viscous porcelain mass onto a chemically inert base, breaking the cast into small pieces after cooling thereof, and subsequently rendering such pieces so far fluid that they assume the desired form.

Ceramic products. A. CARPMAEL. Brit. 297,939, Nov. 21, 1928. Ceramic products having pure white shades are produced by heating the shaped ceramic materials to a red heat of elevated temperature in chlorine or in a gas containing chlorine. As an example, a vessel of unglazed clay is slowly heated to 1000°C in a current of chlorine, this temperature being maintained for 2 hours.

Equipment and Apparatus

Quick change of screen cloth. ANON. *Brick Clay Rec.*, **73** [11], 778 (1928).—The arrangement used to clamp the screen cloth in a Universal screen constitutes a simple and most effective means for a rigid connection between screen cloth and frame which vibrates in unison with it, and insures an even distribution of the vibratory action over the entire screening area. Ample takeup space is provided on each side of the frame, and the screen section is easily removed by releasing the tension on the hook channels which run the entire length of the frame. Angle irons attached to the sides of the screen cloth so that there are no cross members to obstruct the passage of the material over the screen surface make it possible to change from one mesh of wire cloth to another in about five minutes. E.J.V.

Crusher gives desired reduction in one operation. ANON. *Brick Clay Rec.*, **73** [11], 778–80 (1928).—A 3-jaw crusher, made by the Bakstad Crusher and Equipment Co., reduces in one operation any class of material ordinarily fed to crushers, sizes up to 12-in. in the smallest dimension, to a product passing $^1/_2$-in. screen. It can quickly be adjusted also to produce any desired intermediate size up to $2^1/_2$ or 3 in. The primary jaw reduces the large lumps to a size receivable by the two secondary crushing paths directly below, the product from the upper jaw being divided evenly by the separator above the intermediate swing jaw. The movement of the primary jaw is transmitted to the intermediate jaw by a connecting link, causing the secondary crushing units to open and close in unison with the primary jaw. While the combined travel of the secondary jaws is slightly greater than that of the primary jaw, the effective jaw movement for each secondary crushing path is only a little more than one-half of that of the primary jaw. This is important because of the necessity for a shorter jaw movement in the secondary crushing paths, where final reduction takes place. To vary the size of product desired, it is only necessary to change to another size of adjusting jaws. Such adjustment affects all three jaws proportionately, but always leaves the secondary openings equally spaced. With the stationary jaw of the primary crusher also adjustable by changing to another length of safety toggle behind it, the relation between primary and secondary paths will always be equalized for different

adjustments and provides for variations in friability of mineral aggregates. The actuating mechanism is of the lever type, transmitting the crusher movement to the jaws by the action of an eccentric shaft against the roll supported in the lever. The crushing plates are of manganese steel, reversible for wear and interchangeable from stationary to moving jaw in both the primary and secondary paths. E.J.V.

Air drying in ceramic plants. FROMME. *Feuerungstechnik*, **16** [13], 156 (1928). F.P.H.

Accessory equipment in ceramic plants. RIEDIG. *Keramos*, **7** [20], T7 (1928).—A discussion is given of the advantages of various types of fans and blowers used in ceramic plants. F.P.H.

New sand mixing machine. ANON. *Foundry Trade Jour.*, **39** [628], 144 (1928).—A new type of oil and sand mixer manufactured by Spermolin, Ltd., of Black Swan Works, Halifax, mixes 200 lbs. of sand and oil in 3 minutes. The machine is absolutely safe and fool-proof. L.A.P.

Laboratory experiments on high-temperature resistance alloys. C. J. SMITHELLS, S. V. WILLIAMS, AND J. W. AVERY. *Foundry Trade Jour.*, **39** [629], 161–62 (1928).—Curves for a large number of sag tests made with various nickel-chromium alloys (some containing W and Mo) are given. These alloys were also tested for their resistance to oxidation. Electrical resistances were also measured. The ternary alloys containing 10% Cr develop an oxide layer containing very little of chromic oxide whereas such alloys containing 20% Cr develop a protective oxide containing more than 50% chromic oxide. For satisfactory oxidation resistance the composition of the alloy must be such that the oxide formed contains at least 50% chromic oxide. The ternary alloys containing 20% Cr sag slightly more than the binary alloys having the same Ni content. The influence of impurities is illustrated and discussed. Electrical resistivity-temperature curves for a number of the binary and ternary alloys are all similar in shape and show a maximum of 500 to 550°C. In general, the resistivity at room temperature increases as the Ni content decreases. Substitution of W for Cr lowers the resistivity and similar substitution of Mo raises it. The temperature coefficient of resistance is less for the alloys of higher resistivity, and, in most cases, becomes negative above 600°C. L.A.P.

Diesel engine users organized. ANON. *Cement, Mill, and Quarry*, **32** [12], 56 (1928).—Announcement of the formation of the Diesel Engine Users Society has been received. The object of the society is to advance the art and science of the installation, operation, and uses of the Diesel engine. E.P.R.

Crushing Quincy granite. ANON. *Cement, Mill, and Quarry*, **33** [2], 38 (1928). E.P.R.

Filtration equations. A. J. V. UNDERWOOD. *Chem. and Ind.*, **47T**, 325–29 (1928).—The resistance of the cloth or other filter medium is not merely the resistance to flow exerted by the cloth itself, but the resistance exerted by the cloth covered with a very small layer of the sludge which is being filtered. This combined resistance is very much greater than the sum of the two resistances; the choking of a filter cloth by excessive pressure at the commencement of filtration is an example of how large the combined resistance can be. Hence the assumption that a "scouring" effect takes place during the filtration of heterogeneous compressible materials is to be regarded as not proved, since the error of neglecting the cloth resistance leads to mathematical results similar to those derived from the assumption of a scouring effect. Equations for filtration of incompressible materials can, when modified for cloth resistance, be applied to compressible materials. Twenty-one equations are given. H.H.S.

Nonrigid joint in glass and silica ware. E. I. LEWIS. *Chem. and Ind.*, **47**, 1238–41 (1928).—L. describes a German discovery as seen during a visit to Aachen. Ober-

hoffer required, for a research on gases in metals, a vacuum-tight joint without rubber stoppers or connections. A tubing was devised made of glass or silica jointed on the ball and socket principle, the ball and socket having interchangeable spherical elements. This is now being manufactured by Cornelius Heinz at Aachen. The apparatus is illustrated. Since it is standardized ("normalised" not only for curvature but also for tube lengths) spare parts may be kept for any Heinz analytical set. H.H.S.

Conference on drying, Institution of Chemical Engineers. ANON. *Chem. and Ind.*, **47**, 1250 (1928).—The papers included "Tunnel and Stove Drying," by A. T. Henly; "Rotary Driers," by T. J. Horgan; "Vacuum Drying," by G. W. Riley; "Drying by Pressure," by J. W. Hinchley, and many others on drying problems in various industries all over the world. The conference was held Dec. 6 and 7 at Abbey House, London. H.H.S.

The micro-abraso-tome. B. F. ELLIS. *Science*, **68**, 354–56 (1928).—A description of a new apparatus for rapidly and accurately making thin sections. H.H.S.

Motor-truck haulage of feldspar at N. C. mines. S. T. HENRY. *Eng. Min. Jour.*, **126** [10], 376–78 (1928).—H. shows the great advantages of motor-truck hauling over the old horse-drawn wagon hauling. A.J.M.

Feldspar industry adopts modern grinding methods. ANON. *Eng. Min. Jour.*, **126** [19], 746–47 (1928).—A flow sheet of the process is given. The principal features are: (1) a sorting belt to handle run-of-mine material and to permit selection of the various grades at low cost; (2) a sampling unit that is automatic and efficient; (3) twenty mixing bins of 80-T. capacity each, the contents being accurately ascertained by means of samples taken during filling; widely varying analyses permit blending to meet any desirable specifications; (4) a Ruggles-Coles drier aids in reducing grinding costs and assists in securing close adherence to mesh specifications. A.J.M.

Properties of metals at elevated temperatures. A. E. WHITE. *Proc. Nat. Elect. Light Assn.*, **84**, 1232–38 (1927).—Metals for high temperature requirements are broadly divided as follows: (1) ferrous (cast iron, malleable iron, wrought iron, plain carbon steel, and alloy steel); (2) nonferrous metals and alloys (brass, bronze, and nickel alloys); (3) complex alloys (alloys of cobalt, chromium, tungsten, etc.). A table shows the physical properties of alloy steels at elevated temperatures, and one of tensile strengths and elastic limits of various metals at elevated temperatures. A number of graphs show the relationship between temperature and stress under short and long applications of heat. R.G.E.

Measurement of temperatures in boiler furnaces. J. A. STEIN. *Instruments*, **1** [8], 351–53 (1928).—The various pyrometric devices available for the measurement of boiler furnace temperature are briefly discussed and their limitations mentioned.

A new turbidimeter. W. EWALD. *Instruments*, **1** [8], 371–75 (1928).—The instrument and its construction is briefly described and illustrated.

BOOK

Excavating Machinery. W. BARNES. Published by Ernest Benn, Ltd., London.—This book contains the history of almost every type of excavating machinery known, outlining developments in the various fields, and presents much valuable data which enables the plant man to decide what type of machine is best suited for his work, the capacity to expect from his present machine, and the care necessary for efficient operation. Power shovels, draglines, and crabbing cranes are treated under the following headings: (1) fundamental principles embodied in their design; (2) historical development as demand grows; (3) detailed description of types; (4) construction details; (5) applications to all classes of excavation work; (6) hints to prospective user; (7) working information for user; (8) auxiliary plants; (9) miscellaneous information.

It is illustrated fully. A chapter is included on excavating clay and types of shovel best suited for the various plants. Reviewed in *Brick Clay Rec.*, **73** [11], 768 (1928). E.J.V.

PATENTS

Electric upsetting or jolting machine. FRANCESCO BRERO. U. S. 1,692,327, Nov. 20, 1928. An upsetting or jolting machine comprising a bed, two insulated plates mounted on the bed and connected to the terminals of a source of electricity, a ram mounted on one of the plates and the piston whereof actuates a half-bush coöperating with another half-bush for gripping the work piece, an adjustable anvil arranged on the other plate, a guide and stop support situated on the bed, a plunger axially slidable in the support, a piston connected to the piston of a second ram and adjustable means for regulating the stroke of the piston.

Balanced ball mill. WILLIAM M. BARKER. U. S. 1,692,974, Nov. 27, 1928. A ball mill and the like including walls forming a feed chamber, a discharge chamber and an annular grinding chamber, a plurality of material inlet ports communicating between the feed chamber and the grinding chamber, a plurality of outlet ports communicating between the grinding chamber and the discharge chamber, a plurality of auxiliary inlet ports in the end wall of the grinding chamber for admitting air and the like thereto, and grinding means as balls and the like movable in the grinding chamber for grinding material passing therethrough.

Apparatus for electrical precipitation of suspended particles from gaseous fluids. LODGE-COTTRELL, LTD. Brit. 295,890, Dec. 22, 1927. (Addition to Brit. 216,789.) The membrane previously described in Brit. 230,841 is attached to a hollow member insulated from the walls of the apparatus by an insulator which projects outward from the precipitating space. (*B.C.A.*)

Kilns, Furnaces, Fuels, and Combustion

New fuel gas plants for small scale production of generator gas from various fuels. WALTER KIRNICK. *Feuerungstechnik*, **16** [13], 149–54 (1928). F.P.H.

Burning of coal. FREIHERR V. JÜPTNER. *Feuerungstechnik*, **16** [13], 172–75 (1928).—The following subjects are considered: (1) the burning of pure carbon in oxygen; (2) theoretical considerations of the combustion process; (3) experimental results of Haslam, Adams and Hoskins, Boudouard, and Entwistle and Gladding. F.P.H.

Present status of low temperature coking. H. ILLIES. *Feuerungstechnik*, **16** [19], 217–20 (1928). F.P.H.

Effect of pressure on leakage from underground pipe lines. D. B. LARSON. *Gas-Age Rec.*, **62** [3], 67–68 (1928).—In view of the consistent results of tests it appears that the rule can be established that the rate of leakage from a buried pipe line varies in direct proportion to the pressure. F.P.H.

Principles of physics applied to gas industry. T. A. MIGHILL. *Gas-Age Rec.*, **62** [3], 69–71; [5], 133–34; [6], 161–62 (1928). F.P.H.

Pitot tube is handy instrument. F. M. REITER. *Gas-Age Rec.*, **62** [3], 72 (1928).—R. has found the results obtained by the Pitot tube to be very gratifying, particularly for determining relative flows. Even as an actual home-made meter, it has been very satisfactory. Care should be observed to keep the Pitot tube openings perpendicular to the axis of the pipe and to maintain a nearly stream-line flow of the fluids by keeping away from bends or flow distortions at least 20 pipe diameters. F.P.H.

"Kohlenveredelungs" process, a new low-temperature carbonization plant in Germany. DAVID BROWNLIE. *Gas-Age Rec.*, **62** [5], 129–31 (1928).—Germany has developed a large-scale utilization of lignite and attempts are now being made to inaugurate a similar industrial development in other parts of the world, notably at Yal-

lourn in Victoria (Australia), Saskatchewan (Canada), and also in North Dakota in the U. S. At the present time there is now being completed in Germany at the Golzau, Cothen-Anhalt, of the Schwelwerke Minna Anna A.-G., a huge low temperature carbonization plant which includes eight "Kohlenveredelungs" retorts each having an output of 60 T. of semidried lignite, 15–18% moisture, per 24 hours; *i.e.*, 480 T. equivalent to 800 T. of raw lignite with 50% moisture. This, however, is stated to be a very conservative figure, and it is expected that 1000 T. per 24 hours will be treated. F.P.H.

"Plassmann" process of low temperature carbonization. DAVID BROWNLIE. *Gas-Age Rec.*, **62** [7], 196–98 (1928).—Very interesting in the field of fuel technology is the "Plassmann" process of low temperature carbonization, the invention of Josef Plassmann, controlled by the Chemisch Technische Ges. of Duisburg, Germany, and now also being developed in Great Britain. The process consists in the use of a mechanically continuous retort for the carbonization at not over 1110°F of bituminous coal dust and smalls of a swelling character in such a manner that the plastic change is submitted to both mechanical compression and a natural "internal" compression due to the confinement within the retort walls, giving a hard, dense, and smokeless fuel in large sized pieces, containing about 8 to 12% volatile matter. F.P.H.

Simultaneous removal of ammonia and sulphur compounds from gas. HANS BAHR. *Gas-Age Rec.*, **62** [7], 198 (1928). F.P.H.

Dvorkovitz process of low temperature carbonization. DAVID BROWNLIE. *Gas-Age Rec.*, **62** [12], 354–56 (1928). F.P.H.

Compressor plant operation costs. O. A. PHILPOTT. *Gas-Age Rec.*, **62** [12], 357–59 (1928).—Detail cost figures are given for a medium and a small steam driven gas compressor plant. F.P.H.

Effect of higher pressures on gas distribution. E. L. FISHER. *Gas-Age Rec.*, **62** [13], 385–90 (1928). F.P.H.

Vapor-phase oil gas. THOMAS F. HINTZ. *Gas-Age Rec.*, **62** [13], 394 (1928).—Vapor-phase oil gas is produced by subjecting "gas oil" to progressive heat distillation rather than to an abrupt destructive distillation temperature, yielding a greater volume of noncondensible gas per gallon of oil and gas suitable for blue-gas enrichment. In conjunction with the gas, benzol and toluol are produced in substantial quantities. Vapor-phase oil gas is not a by-product; its preparation is given careful attention, resulting in uniformity of structure throughout, while the apparatus involved for its production is an assembly of standard stock equipment. F.P.H.

Determination of the heating value of fuels. HANS KLAR. *Keramos*, **7** [22], T2 (1928).—A detailed description is given of the apparatus, methods, and calculations used in determining the calorific value of various types of fuels. F.P.H.

The "Astuce" suspended platform (flat arch) and the "U" furnace for rapid recuperative firings. A. DE SAINT-EDME BORNE-BONET. *La Céramique*, **31** [478], 1–3 (1928).—The patented "Astuce" suspended platform can be used in the construction of many types of furnaces and kilns. It is formed of bricks which are suspended individually from a steel framework, withstands rapid changes in temperature and exerts no lateral thrust on the walls of the furnace. B-B. considers "suspended platform" a better term than "suspended roof" or "suspended arch," the terms applied to the American product. The "Astuce" suspended platform in ceramic work provides an excellent metal platform on which to carry out drying operations on the top of a kiln. It makes possible the "U" recuperative furnace. It has an important application in tunnel kilns. The same brick shapes and steel pieces can be used in constructing flat or curved roofs. The shapes are sometimes formed of two pieces, the lower piece being made of a special

refractory. Diagrams of suspended platforms and "U" recuperative furnaces are given. A.E.R.W.

Experimental studies of continuous and periodic furnaces. V. BODIN AND P. GAILLARD. *La Céramique*, **31** [484], 143–48 (1928).—The fifth report of the Technical Service of the French Society of Ceramic Mfrs. (1927). Data summaries for 121 continuous kilns and several periodic kilns were secured. These include 3 faience, 1 stoneware, and 6 porcelain kilns. Four tables give data on continuous kilns; another table and 3 figures summarize the information on periodic kilns. The designs, firing curves, and analysis curves of the flue gases are shown. Research and investigation included (1) effect of additions of silica, grog, etc., on drying; (2) dehydration and decarbonization of calcareous clays; (3) determination of the permeability of tiles; and (4) determination of the modulus of rupture in hollow tile of different shapes. A discussion follows the report. A.E.R.W.

Installation and efficiency of an improved continuous kiln. A. COULTHON. *La Céramique*, **31** [484], 148–54 (1928).—The Coulthon continuous kiln is described in detail. Its construction, operation, and theory are discussed and illustrated with diagrams. The kiln is coal-fired, and consists of a gallery forming a circuit and provided with transverse hearths fed from holes placed below the arch. Flues and dampers are arranged for utilization of waste heat. Economies in fuel and high output from small kilns are claimed. A.E.R.W.

Heat control and its transfer. ELLSWORTH P. OGDEN. *Brick Clay Rec.*, **73** [12], 820–21 (1928).—The relation of cause and effect in draft regulation and changes in flue systems and setting arrangements are more or less obvious, and manipulations of this kind have been made and observed ever since the earliest days of clay firing. Observations, however, are not always correct, deductions are sometimes faulty, and corrective measures frequently fail. An understanding of the principles involved is necessary. Every system, or combination of fuel, furnace, and draft, has a definite rate of combustion, and a maximum attainable temperature that is fixed between narrow limits. Each clay product or other refractory product will mature under certain conditions of time temperature effect. In any commercial kiln, however, the element of time is reasonably uniform, so temperature should also be uniform. The greater the margin between the maximum attainable temperature for a given system and the maximum required temperature for the ware, the easier the problem of firing. In firing refractories, temperatures are required which approach the maximum attainable temperature for the system of kiln and fuel; in the higher grade refractories the maturing temperatures approach the actual fire box temperature. The three methods of heat transfer (conduction, convection, and radiation) are discussed and illustrations in face brick, refractory, and round kilns are cited. The importance of adequate draft is stressed. E.J.V.

Oil firing for Russian insulators. ANON. *Pottery Gaz.*, **53** [618], 1953 (1928).—In an insulator factory, oil has been adopted in place of wood for firing. A new type of furnace has been designed by the engineers, A. T. Helman and E. G. Solovieff, for the consumption of this fuel. One furnace was started in June, 1927, and a second one October, 1928. The floor of the kiln is of special construction to facilitate a uniform distribution of temperatures, assisted by the use of screens. The firing is arranged to supply heated air. There is a special system for regulating the supply, filtering, and heating the fuel oil as it reaches the furnace. Experience with the first furnace has shown that the new method of firing is very economical. The waste with wood firing was exceedingly heavy, but now it has fallen to 18 to 19%. The process of firing has been speeded up by 37%, and the production has been doubled. The cost of fuel per fur-

nace is down from 880 to 440 roubles, resulting in a 50% reduction in insulator costs. E.J.V.

Industrial electric heating. ANON. *Proc. Nat. Elect. Light Assn.*, **84**, 427–31 (1927).—An index covers the more important and interesting articles on industrial electric heating that have appeared in the various trade journals and publications during the years 1925 and 1926. The index is divided into: (1) melting furnaces; (2) heat treating furnaces; (3) vitreous enameling furnaces; (4) ovens; (5) types of furnaces and refractories; (6) liquid and compound heating; (7) general articles on electric heating; (8) comparative costs of electric heating installations. The bibliography should be a valuable asset to every power and industrial heating engineer who is following industrial electric heating applications. R.G.E.

Stacks and flues. ANON. *Proc. Nat. Elect. Light Assn.*, **84**, 839–41 (1927).—In order to compare performances of stacks and to draw definite conclusions from collected data it is evident that uniformity must be adopted in obtaining data. In order to obtain this uniformity an outline is presented for analyzing stack performance. The suggested outline definitely establishes the number and location of observation stations, and the number of observation points per station. The importance of obtaining representative temperatures and gas analyses at each station is stressed. The procedure and calculations are given under forty-three items. While the outline is primarily made for the products of combustion of coal, it is applicable to other fuels by taking into consideration a few minor items. R.G.E.

Pulverized fuel. ANON. *Proc. Nat. Elect. Light Assn.*, **84**, 1240–1358 (1927).—This report covers the use of powdered coal by a number of power companies and shows the extent to which pulverized fuel is now used in firing boilers in the U. S. and Canada. Tables of pulverized fuel installations using unit and central type systems are given. The report shows an increase in the use of the turbulent type of burners, preheated air, and water-cooled furnace walls. Data are given on sampling powdered coal. Burners, pulverizers, and furnaces are discussed. Statements are quoted of both operating companies and manufacturers. The statements by operating companies contain data on the operation and maintenance of pulverized fuel boiler plants. Cost data are included for many of the installations. A bibliography of recent literature pertaining to pulverized fuel is appended. R.G.E.

New Coal Age. Edited by R. W. Johnson. *Chem. and Ind.*, **47**, 1251 (1928).—A new journal published monthly at 1 Buckingham street, London, price sixpence, and devoted to the scientific treatment of coal. The first number sets out the aims of the journal, and carries articles on the story of smokeless fuel, low-temperature carbonization, pulverized fuel, etc. H.H.S.

PATENTS

Kiln car. HALVER R. STRAIGHT. U. S. 1,694,085, Dec. 4, 1928. In a device of the class described, a car frame, a floor supported thereon, a retainer frame supported on the floor and capable of horizontal movement relative to the car frame, and a series of floor blocks carried by the floor and within the retainer frame.

Kiln. BARTHOLOMEW H. GREENE. U. S. 1,694,650, Dec. 11, 1928. A kiln having a floor, side walls and a crown, and refractory shelves adjacent to the side walls and extending from the floor to the crown, for supporting articles to be fired, the shelves being spaced at their rear edges from the side walls.

Multiple-chamber kilns. E. G. SPENCER-CHURCHILL. Brit. 296,844, Oct. 31, 1928. In a continuous, multiple-chamber downdraft kiln, the chambers are arranged in pairs about a common chimney and the chambers of each pair are separated by a common end wall. A flue connects the base of one chamber to the bag of the next chamber past a damper and leads directly to the chimney past a damper. To prevent

direct passage between the chimney flues the chimney has a midfeather extending about $^1/_8$ of its height.

Kilns. CARBORUNDUM CO., LTD. Brit. 297,241, Nov. 7, 1928. In a kiln for firing terra cotta, sanitary ware, etc., by direct contact with heating gases, and having a refractory combustion chamber, the waste gas outlet ports are distributed substantially uniformly over the floor of the kiln, and open into transverse flues communicating with a longitudinal flue. Preferably two combustion chambers are provided, one at each side of the kiln chamber, and the lower parts of the bag walls may be made of material having a higher thermal conductivity than that of the upper parts.

Gas producer for carbonization and degasification of fuel containing dust. H. STOKOWY. Ger. 458,265; *Gas-Age Rec.*, **62** [3], 84 (1928). F.P.H.

Geology

Cyanite as found in western North Carolina. A. H. FESSLER AND WM. J. MCCAUGHEY. *Jour. Amer. Ceram. Soc.*, **12** [1], 32–36 (1929).—This article describes briefly the deposits, formations, geology, and economic value of the mineral cyanite as found in western North Carolina.

Geology of important German kaolin and clay deposits. W. DIENEMANN. *Ber. deut. keram. Ges.*, **9** [9], 507–13 (1928). F.P.H.

Origin and occurrence of ceramic raw materials of North Bavaria. A. LAUBENHEIMER. *Ber. deut. keram. Ges.*, **9** [9], 521–25 (1928); *Keramos*, **7** [17], T5 (1928). F.P.H.

Mining, production, and purification of ceramic raw materials of Upper Franconia and Upper Palatinate. F. BLEY. *Ber. deut. keram. Ges.*, **9** [9], 525–33 (1928); *Keramos*, **7** [17], T5 (1928). F.P.H.

"Teregova" feldspar and quartz works. GUSTAV KOPPA. *Keramos*, **7** [20], T5 (1928).—The physical and chemical properties of the "Teregova" feldspar manufactured by the Feldspat und Quarzwerke Teregova, A.-G., Wein are described. F.P.H.

Production of soda and borax salts in 1927. ANON. *Eng. Min. Jour.*, **126** [1], 17 (1928).—Production of sodium compounds, not including common salt, from natural salines and brines in the U.S. in 1927 amounted to 145,770 T. valued at $3,834,324. These figures include soda ash, sodium bicarbonate, salt cake, and glaubers' salts, borax, kernite, and trona. The sodium carbonates amounted to 67,240 T. valued at $1,253,352; 23,080 T. of sodium sulphate were produced and valued at $168,882. The total boron minerals shipped in 1927 amounted to 109,080 T. valued at $3,473,399. A.J.M.

Feldspar production decreased 4% in 1927. ANON. *Eng. Min. Jour.*, **126** [7], 252 (1928).—Crude feldspar sold or used by producers in the U. S. in 1927 amounted to about 202,497 long tons, valued at $1,424,755. These figures show a decrease of 4% in quantity and 11% in total value compared with 1926. N. C., the leading state, reported about 50% of the total output; Maine, second with nearly 17%; and N. H. third with nearly 14%. Feldspar was also produced in Ariz., Calif., Colo., Conn., Md., N. Y., Pa., S. D., and Va. There was an increase in imported feldspar as compared with 1926. A.J.M.

Asbestos milling and dressing for the market. EUGENE LAROCHELLE. *Cement, Mill, and Quarry*, **32** [12], 70–74 (1928).—The serpentine of Quebec is more or less seamed and impregnated with chrysotil asbestos, of which there are two types: the cross-fiber and the disseminated fiber. The cross-fiber type always appears in fibers or crystals arranged parallel to one another, and disposed at right angles to the walls of the matrix serpentine. The length of the fiber of these veins, which run in every

direction, varies from microscopic dimensions to 4 or 5 in. Asbestos, as it is put on the market, is divided into two classifications, "crude" and "fiber," which are respectively subdivided into various grades. The "crude asbestos" consists of veins of asbestos, of the cross-fiber type, the length of which is $^{3}/_{4}$ in. or longer. The process of converting it into a salable article is hand "cobbing" as opposed to the mechanical treatment through which the fiber is obtained from both types of asbestos-bearing rock. Market requirements cover length, strength, color, and chemical composition. The length of the fiber is the most important factor to be considered. To meet the demands of the market, a standard method of classifying fiber has been adopted by which the length of figure is controlled. The entire process of asbestos milling and dressing is described in detail. E.P.R.

Asbestos and its industrial application. W. BAIN. *Chem. and Ind.*, **47**, 1186 (1928).—Canada is the chief asbestos-producing country, but deposits exist in Russia, Italy, U. S., Japan, India, and S. Africa. S. African blue asbestos (which contains more iron oxide than the white variety) is in demand owing to its resistance to strong acids. During the last few years the industrial use of asbestos has increased enormously. It can be spun and woven, is employed as an insulator of heat, sound, or electricity, and its use in the form of paper for deeds has been suggested. It is a filtering medium and a building material. The aim of each stage in its production from the native rock (usually open quarries) is to see that the length of the fiber is not shortened. H.H.S.

Potash in Spain. ANON. *Chem. and Ind.*, **47**, 1250 (1928).—Deposits of potash in the rock-salt region of Cardona, northern Spain, include 80 m. of carnallite and 10 m. of sylvine over an area of 100,000 hectares. H.H.S.

Gypsum industry in Canada. L. H. COLE. *Industrial Canada*, **29** [7], 122 (1928).—Gypsum is mined or quarried in N. S., N. B., Ont., Man., and B. C., and in each of these provinces there is other property capable of furnishing high-grade material when the market warrants its exploitation. The largest company is the Canada Gypsum and Alabastine, Ltd.; others are the Canadian Gypsum Co., Atlantic Gypsum Products Co., Nova Scotia Coal and Gypsum Co., Ingonish Gypsum Co., Iona Gypsum Products, Ltd., and Albert Mfg. Co. Several new companies have reached production stage. Formerly only a small proportion of the gypsum mined in Canada was calcined there. In 1927, 192,000 T. were made into wall plaster, gypsum wall board, gypsum blocks, and insulating material. H.H.S.

Occurrence of germanium. JACOB PAPISH. *Science*, **68**, 350–51 (1928).—A search for Ge in pegmatite, high-temperature vein numerals, and gangue materials, has resulted in the discovery that topaz, in its massive and crystalline forms, contains Ge. Among the 27 localities are Trumbull, Conn., Stoneham, Me., Florissant, Colo., Naegi Mino, Japan, and Silver Leaf Mine, Manitoba. H.H.S.

Building materials in Manitoba. R. C. WALLACE AND L. GREER. *Arch. and Bldg.*, **60** [4], 134 (1928).—A report on the nonmetallic mineral resources of Manitoba is now obtainable from the Industrial Development Board of Manitoba, Winnipeg, Canada. The chief interest in this report lies in the resources in building stone, cement rock, clays and shales for brickmaking, dolomite, gypsum, lime, limestone, monumental and ornamental stone, sands, stucco materials, coal, oil, etc. These are discussed under three main headings of structural building materials, fuels, and miscellaneous minerals. E.P.R.

Silica in relation to industry. J. A. BENELL. *Cement, Mill, and Quarry*, **32** [12], 59 (1928).—Silica is one of the greatest single constituents of modern industry. The major portion of all sand is silica and should be its principal component part in building materials. As an abrasive for cutting, polishing, and sandblasting, sand serves a vital purpose in many industries. Some of the commoner uses are in chemical industry,

paint, mineral fillers, ceramic products, insulation, structural materials, glass, refractories, and abrasives. In moderate climates as in California, the use of stucco in building construction is ever increasing. Stucco which resists weathering must be composed of materials which are not soluble in water and impervious to the various gases often carried in the atmosphere. For this reason sand of the highest silica content is sought. Carbonates should be absent. When the proper high-content silica sand is used in concrete and properly mixed with reliable cement, the best roadbed is secured. The oxychloride cements (misnamed magnesite) when properly mixed with silica sand, together with the same sand from 100- to 400-mesh, used as a filler, give the finest flooring material. With ever-increasing demands on the timber supply the demand for silica in all its various forms will increase as a base for building material. The soap industry has found that silica is an important element in the manufacture of heavy cleansing soap. E.P.R.

Exploitation of high-silica rocks. II. P. G. H. BOSWELL. *Refract. Jour.*, **4** [37], 18–19 (1928).—B. gives a detailed survey of the industrial uses of sands of all sorts with different physical properties. British resources are given. E.P.R.

Consumption of primary or virgin tin in U. S. in 1927. J. B. UMHAU. Bur. Mines, *Information Circ.*, No. 6084 (Oct., 1928).—This circular gives a total consumption of 68,797 long tons of primary tin, a quantity equivalent to 96.7% of the imports for the same year. A tabulation is given of the uses of this metal together with the percentage used for each purpose. R.A.H.

Fluorspar and cryolite in 1927. HUBERT W. DAVIS. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 9–25 (1927).—Fluorspar is a nonmetallic crystalline mineral that usually occurs in glassy transparent isometric crystals, largely cubic, or in cleavable masses. It has a specific gravity of 3.2, is brittle, and has a hardness of 4. Salient features of the fluorspar industry in 1927 are the decrease in domestic shipments, the pronounced increase in the imports from Germany, the equally pronounced decrease in the imports from the United Kingdom, the large stocks of fluorspar at consumers plants on Dec. 31, 1927, and the increase in producers stock piles, which are the largest on record. Shipments of fluorspar to steel plants by domestic producers in 1927 were 12% less than in 1926; there were also decreases of 27 and 21% for use in foundries and glass plants. The exports in 1927 were the smallest since 1921. Shipments of fluorspar to manufacturers of enamel and of hydrofluoric acid exceeded those of 1926 by 12 and 10%, respectively. Shipments of fluorspar for use in the Portland cement industry increased decidedly over 1926, amounting to a total of 685 short tons. Average value per net ton was $18.08 or 12% lower than in 1926. Aggregate value of shipments for the year was $2,034,728 for 112,546 short tons, a decrease of 13% over 1926. Detailed statistics of value and production as well as use are included. A short paragraph on cryolite states that the imports from Greenland, the only deposit of commercial value, were 5064 long tons valued at $410,876. R.A.H.

BOOK

Geology. A. P. BRIGHAM, revised by F. A. Burt. Pp. x + 554, 325 illustrations. D. Appleton & Co., New York, 1928. Price $3.00.—Dynamical, structural, historical, and economic. H.H.S.

Chemistry and Physics

Plasticity and related properties of clays. D. R. IRVING AND W. F. DIETRICH. *Jour. Amer. Ceram. Soc.*, **12** [1], 14–30 (1929).—This paper presents the results of Talwalkar-Parmelee plasticity measurements of a number of clays, and an interpretation of the results in the light of data on dye adsorption, water of plasticity, drying and firing shrinkage, and dry transverse strength. The clays studied are mainly from California, but tests of a few more widely-known clays from other sources are included for the

purposes of correlation. Some data are given to show the effect of the addition of fine sand on the plasticity of a clay. The effect of variations in the water of plasticity is also considered.

Electrodynamics of surface catalysis. A. KEITH BREWER. *Jour. Phys. Chem.*, **32** [7], 1006–17 (1928).—B. treats the subject as a special case of thermionic emission in gases. Certain observed facts, the emission of ions during various surface catalyzed chemical reactions following an equation of the Richardson type and the concentration of these ions increasing as the inverse cube of the distance upon approaching the surface, are made the basis for the proposed mechanism of surface catalysis. The mechanism is that the gas molecules upon approaching the surface are dissociated into ions by the combined image and intrinsic forces of the catalyst. The ions so formed are driven from the surface by kinetic agitation with a probability distribution of velocities. Chemical action results from a combination of the ions whose velocity components perpendicular to the surface are sufficient to carry them out to a region of weak surface forces, the chemically active region. The equation for rate of the forward reaction developed from this point of view is $dC/dt = A'T^{n'/2}e^{-b'/T}$ where A is the combination factor and b is the complete chemical work function. The back reaction is expressed by the same equation but with different values for the constants. Equilibrium, therefore, is expressed by $K = \frac{A'}{A''} T^{\frac{n''-n'}{2}} e^{-(q-b')}$. L.A.P.

Relation between specific volume, voids, and size composition in systems of broken solids of mixed sizes. C. C. FURNAS. Bur. Mines, *Rept. of Invest.*, Serial No. 2894, (October, 1928).—A more definite knowledge of the relation between space occupied and size composition would be valuable to all those who are handling large quantities of broken materials. The data presented in this paper should also appeal to those interested in saving space in the storage of materials such as coal, ore, and rock. A further application can be found in the storage and handling of slugs, or any mixture of suspended solids in a liquid. For most efficient handling, such a system should be at a maximum density. The method developed enables a person easily and accurately to predict the composition of maximum density for such a system. Data are given for the change of percentage of voids with composition in systems of broken solids of 2-component sizes. These data are generalized into 3 sets of curves showing the relation between size ratio, composition, and voids, in various beds of broken solids in which there are 2-component sizes. Maximum voids in beds of broken solids are obtained by separating each size into a separate layer. Minimum voids, and hence the least lost space in storing, are obtained by piling the materials in layers with 2 sizes, one large and one small in each layer. The application of these rules and the data are explained and applied to the storage of coal or other broken material. The relations between the specific volume and composition of 2 component systems are developed. A very simple graphical method for the determination of the composition of maximum density is explained. The method outlined can be applied to the computation of mixtures of maximum density of brick or other ceramic materials or to concrete. R.A.H.

X-ray identification and specification of asbestos. GEORGE L. CLARK. *Cement, Mill, and Quarry*, **33** [2], 24 (1928); *Asbestos* (August, 1928).—The article deals with the analysis differentiation and identification of numerous varieties of asbestos minerals. E.P.R.

Silicic acids. R. SCHWARZ. *Zement*, **17** [24], 930–33 (1928); *Rock Prod.*, **31** [24], 92 (1928).—SiO_2 can form at least two hydrates, the meta-acid ($SiO_2 \cdot H_2O$) and the di-acid ($2SiO_2 \cdot H_2O$), which are both at least hexametric. The di-acid forms in the direct disintegration of the corresponding alkali-silicate in crystalline condition; in amorphous

shape it appears in the silicic-acid gels which are formed by the hydrolysis of watery alkali-silicate solutions. The meta-acid forms in the surface-chemical decomposition of the sodium meta-silicate and is furthermore found also in those gels which are formed in the hydrolysis of silicium combinations in the cold such as SiF_4 or $SiCl_4$. In the alkali-silicate solutions the clays SiO_2 and Si_2O_4 are found in an equilibrium which is shifted with increasing hydrogen-ion concentration in favor of Si_2O_4. F.P.H.

Change of compressibility with pressure. L. H. ADAMS. *Jour. Wash. Acad. Sci.*, **17** [21], 529–33 (1927).—The change of compressibility with pressure for crystalline solids is by a rough approximation dependent on the compressibility itself, the two quantities increasing together. The mutual relation is more obvious if the halides of the heavier alkalis be excluded; 85% of the remaining observations deviate from a single smooth curve by an amount which is hardly greater than the experimental error. A.J.M.

New equation for determining surface tension from the form of a sessile drop or bubble. N. E. DORSEY. *Jour. Wash. Acad. Sci.*, **18** [19], 505 (1928).—The measurements can be made upon a suitable photograph of the profile of the surface of a drop. From the measurements values may be substituted in the equation or determined from a table which is given. A.J.M.

Bubbles, drops, and Stokes' law. II. W. N. BOND AND D. A. NEWTON. *Phil. Mag. and Jour. Sci.*, **5** [30], 794–800 (1928).—Spherical drops or bubbles surrounded by a more viscous fluid may have a terminal velocity as great as $1^1/_2$ times that of a solid sphere of equal size and mass. It is shown experimentally and theoretically that the surface tension of the drop or bubble decreases the terminal velocity. For any radii appreciably less than a certain critical value the drop or bubble behaves almost like a rigid sphere. After a fairly rapid transition, for all radii appreciably larger than the critical the effect of surface tension is small. Experiments on the terminal velocity for air in water glass, air in syrup, mercury in syrup, and water in castor oil, all give critical radii of the order predicted; but the different media show appreciably mutual disagreement, the cause of which is not yet certain. J.T.L., JR.

Synthesis of substance having properties analogous to Japanese acid clay. I. NAOTO KAMEYAMA AND SHUMPEI OKA. *Jour. Soc. Chem. Ind., Japan*, **31** [11], 269–71B (1928).—According to Kobayashi, the analysis of Japanese acid clay gives silica (49.90 to 68.42%) and alumina (9.83 to 20.86%). As minor constituents, it contains ferric oxide, calcium oxide, magnesia, and alkalis. The molecular ratio of SiO_2 to all basic constituents calculated as Al_2O_3 is 6:1. From these analytical data, K. and O. supposed that the colloidal silica plays an important part in the various properties of the Japanese acid clay. Therefore (1) a pure solution of silicic acid was prepared from recrystallized sodium meta-silicate by means of electrodialysis, and several kinds of silica gel were prepared by drying the solution under different conditions. (2) Several kinds of silica gel containing alumina as much as 1 mol per 6 mol SiO_2 were prepared from pure silicic acid solution and colloidal aluminium hydroxide. (3) Silica gel containing alumina and ferric oxide was prepared from silicic acid solution, colloidal aluminium hydroxide, and ferric hydroxide. This substance showed nothing better than the former two. From these 3 trials, substances having qualitatively all the known properties of the Japanese acid clay except the oxidizing power were obtained. The most of these properties are due to colloidal silica, and the addition of alumina strengthens the acidic properties. Among these properties of this artificial material, some are weaker compared with the Japanese acid clay, but it may be possible to get a better one by improving conditions of preparation. The oxidizing power may be due to the minor constituents other than silica, alumina, and ferric oxide, and in the second report the point will be treated. E.J.V.

Melting point diagram of cryolite-barium fluoride. NAOTO KAMEYAMA AND EIICHI MASUDA. *Jour. Soc. Chem. Ind., Japan*, **31** [11], 271–72B (1928).—The freezing point and eutectics of the binary mixtures of cryolite and barium fluoride were determined by means of cooling curves. Cryolite used for the measurements was prepared by treatment with hydrofluoric acid of the cryolite that was obtained from Merck. The purified product gave 24.30% Al_2O_3 (the theoretical value is 24.27%) and 0.04% of the insoluble matter in sulphuric and hydrochloric acid and 0.07% Fe_2O_3. Barium fluoride was prepared by double decomposition of barium chloride and sodium fluoride. As sodium fluoride (even the product of a notable firm) was found to contain much sulphate, it was purified by precipitating the sulphate with benzidine chloride. The product obtained by double decomposition was purified by extraction with boiling water and ignition, and the purified product contained 0.19% NaF and 99.48% BaF_2. For the cooling-curve determination, 40 g. of the mixture was taken in each of the platinum tubes, one 15 mm. in diameter and 95 mm. in height, the other 20.5 mm. in diameter and 70.5 mm. in height. The end of the thermo-element was put in the salt directly. The results obtained are as follows:

Composition of mixture BaF_2 in the mixture		Beginning of freezing	Eutectic point
By weight	By mol ratio		
0	0 (Cryolite)	1014°C	
20	23.0	982	819.5°
40	44.4	931	830
55	59.4	877	837
61	65.2	844	834
64	68.1	840	835
67.5	71.3	856	835
70	73.6	875	833
77.5	80.5	944	828
85	87.2	1025	820
100	0 (BaF_2)	1324	

The result shows that there is an eutectic point 835°, the eutectic mixture composed of barium fluoride 62.5% by weight, or by molecular proportion nearly BaF_2/Na_3AlF_6 = 2/1. No compound was found. E.J.V.

Potentiometric and conductometric analysis, and their industrial application. T. CALLAN AND S. HORROBIN. *Chem. and Ind.*, **47T**, 329–43 (1928).—Volumetric analysis has hitherto proceeded in the main along the conservative line of marking a color change at the end-point. Newer and often advantageous are the electrometric methods of potentiometry and conductometry. The former depends on a sudden change in potential of a suitable electrode, immersed in the solution, at the end-point. The latter depends on the change in conductivity of the solution as the titration proceeds. The methods are quite distinct and require different apparatus. These methods are described, using the simplest apparatus. H.H.S.

Determination of small quantities of antimony as stibine. J. GRANT. *Chem. and Ind.*, **47**, 1220–21 (1928).—An improved apparatus, of the electrolytic type for carrying out the Marsh test for As, is used to estimate Sb as SbH_3. H.H.S.

Amateur photomicrography. P. M. MALLET. *Photographe*, March, pp. 99–103 (1928).—A preface and the first chapters of an elementary discussion of photomicrographic work; optics, lenses, choice of microscopes, and construction details are discussed.

The vapor pressure of barium oxide. M. DEKAY THOMPSON AND W. G. ARMSTRONG. *Trans. Amer. Electrochem. Soc.*, **54** (preprint), 4 pp. (1928).—The vapor pressure of Ba oxide was measured between 1280° and 1470° by saturating a measured volume of air with the vapor of the oxide, and determining the amount of oxide required: 1100°,

0.03 mm. Hg; 1200°, 0.12 mm. Hg; 1300°, 0.42 mm. Hg; 1400°, 1.6 mm. Hg; 1500°, 5.6 mm. Hg; 1600°, 20.0 mm. Hg; 1880°, 760 mm. Hg. (*C.A.*)

Sampling of granular materials. BERNHARD BAULE AND A. BENEDETTI-PICHLER. *Z. anal. Chem.*, **74**, 442–56 (1928).—By means of the laws of probability, equations are developed showing how the errors due to sampling can be computed. From these it is easy to find what weight of sample should be taken for analysis. This is illustrated by practical examples. The application of micro methods to the analysis of mixtures is also discussed and the formulas of Mika are shown to hold true only for a special case. The original paper must be consulted for details. (*C.A.*)

Plasticity. IV. Plastic materials from silica. OTTO RUFF AND BRUNO HIRSCH. *Z. anorg. allgem. Chem.*, **173**, 14–26 (1928).—A quartz containing 98.8% SiO_2 and having a particle size of 2 to 8μ was used. By prolonged treatment with acid, washing, grinding, centrifuging, dialyzing, and rapid drying *in vacuo*, samples of high purity with a particle size of 1.2$\mu\mu$ (average for sample A_3) were obtained. Samples of 50 g. each of these silica preparations of varying particle size were treated with NaOH, HCl, HNO_3, H_2SO_4, $(COOH)_2$, H_3PO_4 and CH_3COOH in several concentrations. The samples treated with alkali did not mold satisfactorily, *i.e.*, cracks developed and the body adhered to the mold. Treatment with HCl gave much better results. In general, the finer particle size and the higher concentration of acid produced better molding qualities (plasticity and minimum shrinkage). Under similar conditions, treatment with HCl and HNO_3 of the same concentration produced similar results. Bodies molded from slips treated with the other acids were not as satisfactory, showing that the H-ion concentration is the important factor. The effect of neutral salts in analogous treatment shows that the H-ion concentration as determined by anions of the salts is here again the controlling factor. Neutral slips produced bodies that did not crack, provided the particle size was sufficiently small (1.2μ). Improvement in plastic properties is ascribed to adsorption of H^+. The actual amount of H-ion adsorption was small and it was not established with certainty. The swelling effect increased to a maximum at the highest concentration of HCl used. (6 *N* was obtained by passing in HCl gas.) The H-ion concentration of the superficially hydrated SiO_2 is p_H 4.85. The observations are explained on the assumption of a diffusion equilibrium of the mobile H-ion between the interior of the quartz grains and the dispersion medium and a hypothetical formation of polar molecular groups at the surfaces of the quartz particles ("cover formation"). This hypothesis is discussed in detail. (*C.A.*)

The influence of the volume of solution and the mass of adsorbent on the adsorption of arsenous acid by metal hydroxides. K. C. SEN. *Z. anorg. allgem. Chem.*, **174**, 75–81 (1928).—The adsorption of As_2O_3 by $Zr(OH)_4$ was measured for volumes of solution between 50 and 200 cc. and with amounts of hydroxide between 0.27 and 1.08 g. For the same final concentration of solute the adsorption per g. of adsorbent is greater the smaller the total volume of solution. The amount of adsorption per g. of adsorbent appeared to decrease as the amount of adsorbent was increased although experiments on this point were not decisive. Similar results were obtained with Al and Cr hydroxides. (*C.A.*)

BOOKS

Laboratory Manual for the Clay Industry. H. BOLLENBACH AND E. KIEFFER. Published by Wilhelm Knapp, Halle(Saale), 1929. 2nd ed. with 55 illustrations. 6.90 M. post free. Reviewed in *Brit. Clayworker*, **37** [439], 317 (1928).—Advances in clay technology have been so rapid that this 2nd edition has been necessary. The divisions of the work progressively deal with the researches required in order to obtain a chemical and physical knowledge, and is complete in its details of a sample of clay. Instructions are given on how to take samples, make a preliminary examination, prepare the pieces

into shape with water, dry and fire them, and take drying and shrinkage measurements. Other properties such as plasticity, tenacity, moldability, viscosity are discussed as well as such tests as sieving analysis, sedimentation, and tritration with illustrations of the most approved apparatus for making these tests. The book discusses and describes methods of measurements of all the well-known tests for measuring physical and chemical properties of clays. A section is concerned with glazes and another with sundry laboratory equipment and furnaces. R.A.H.

Determination of Minerals under the Microscope. JOHN W. EVANS. Thomas Murby Co., London. 110 pp. 7*s* 6*d*. Reviewed in *Min. and Met.*, 9 [264], 568 (1928).—The purpose of this book is to assist students to realize the principles on which the optical study of minerals rests without the use of advanced mathematics. It discusses in considerable detail the petrological microscope and its accessories, the methods used in identifying crystals with its aid, and the optical theory involved. F.P.H.

Microscopy of Technical Products. T. F. HANAUSEK. Trans. by A. L. Winton. 471 pages, 276 figures. John Wiley & Sons, Inc., New York, 1928. Price $5.00.—Part I deals with apparatus, accessories, and technique, Part II with the microscopy of materials. There is a chapter on microchemical analysis. H.H.S.

Colloid Chemistry. THEO. SVEDBERG. 2nd. ed. Chemical Catalogue Co., New York, 302 pp. Price $5.50. Reviewed in *Min. and Met.*, 9 [264], 567–68 (1928); for review see *Ceram. Abs.*, **7** [11], 791 (1928). F.P.H.

Quantitative Analysis. Vol. II. 7th ed. F. P. TREADWELL AND W. T. HALL. 792 pages. John Wiley & Sons, Inc., New York, 1928. Price $6.00. H.H.S.

Methods of the Chemists of the U. S. Steel Corp. for the Sampling and Analysis of Gases. 3rd ed. Published by Carnegie Steel Co., Bureau of Instruction, Pittsburgh, Pa. 187 pp. $2.25. F.P.H.

PATENTS

Method of treating mixtures containing alkali salts of certain metals. GEORGE E. DALBEY. U. S. 1,693,641, Dec. 4, 1928. The method of treating mixtures containing sodium-metallic salts to recover valuable products, which comprises dissolving any caustic soda which may be present in the mixture and separating it from the undissolved materials, dissolving the metal salts other than sodium plumbate and plumbite and any sodium pyro-antimonate that may be present due to the action of water on sodium antimonate in the original mixture, separating such solution from the undissolved materials, treating the undissolved mixture of sodium plumbate and plumbite and sodium pyro-antimonate to obtain metallic lead and sodium pyro-antimonate, and treating the solution of metal salts to obtain stannic acid.

Titanium dioxide. I. G. FARBENINDUSTRIE AKT.-GES. Brit. 296,730, Oct. 31, 1928. The hydrolysis of titaniferous solutions, *e.g.*, those obtained from ores by treatment with sulphuric acid, is effected in the presence of hydrofluoric acid or a soluble fluoride. An easily filterable product which remains white even when ignited at 900°C is thus obtained. The hydrolysis may be effected by boiling the solution, and water may be added as the hydrolysis proceeds to reduce the concentration of free sulphuric acid.

Calcium nitrate, alumina, phosphorus, silica. J. Y. JOHNSON. Brit. 296,832, Oct. 31, 1928. A raw phosphate is fused in known manner with coaly matter and aluminous material such as bauxite, kaolin, clay, or loam to distill off the phosphorus, and the resulting slag is converted and separated into calcium nitrate, alumina, and silica. Preferably the process is so conducted that iron present is reduced and tapped out as a phosphite-bearing pig iron and the addition of bauxite, etc., so regulated that the slag obtained contains 45 to 60% calcium oxide, 10 to 40% aluminium and ferric oxides, and 30 to 10% silica, since such a slag disintegrates on cooling and is readily decomposed by

acids. The slag is treated with nitric acid to bring the calcium and aluminium into solution and the silica separated and treated for use as an absorbent or insulating material, or for agricultural purposes. From the nitrate solution the aluminium together with any iron is precipitated by milk of lime or calcium carbonate, preferably in the presence of a small percentage of compounds such as brown coal tar oils, coal tar oils, or tetrahydronaphthalene to reduce the bulk of the precipitate. From the remaining solution the calcium nitrate is recovered in solid form. An example of the treatment of a Morocco phosphate is given.

Sodium perborate. ROESSLER AND HASSLACHER CHEMICAL CO. Brit. 297,777, Nov. 21, 1928. Sodium perborate is obtained by treating a borax solution first with sodium peroxide, preferably at temperatures between 12 and 20 °C, until metaborate and some perborate is formed, and then with hydrogen peroxide, preferably at temperatures between 8 and 12 °C, to complete the oxidation. Preferably 1 molecule of sodium peroxide and 3 of hydrogen peroxide are used for each molecule of borax, whereby the crystals of perborate obtained by cooling the final solution to 0 are free from impurities and the mother liquor may be used in a succeeding operation.

Aluminum chloride. RICHARD J. DEARBORN. Can. 283,609, Sept. 25, 1928. $AlCl_3$ is made by continuously and simultaneously coking and purifying a mixture of Al ore and carbonaceous material by heating and chlorinating at a relatively low temperature under conditions that no substantial chlorination of Al occurs, and then without loss of heat chlorinating the purified coked mixture at a relatively high temperature. (*C.A.*)

Manufacture of alumina. AKTIESELSKAPET NORSK ALUMINUM CO. Norw. 44,305, Aug. 15, 1927. Alumina with a low content of SiO_2 is extracted from aluminous slag and similar materials by treating with a solution containing approximately 80 g. per liter of alkaline Na compounds calcined as Na_2CO_3, about 10% of which is present in the form of free NaOH. Some Na aluminate may also be present in the solution. (*C.A.*)

General

The greater American Ceramic Society. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [12], 343–45 (1928).—There has been no questioning of the value that would accrue if, for the promotion and prosecution of ceramic research and education, there was in America one organization supported by all the varied ceramic industrial interests. The plan of organization and operation of the SOCIETY is that of centralized general activities with decentralized particular activities according to industries. It is but a small step for the trade associations to merge their product research activities in a special Division of the SOCIETY. The American Refractories Institute is considering this and the preliminary statement of the scheme adopted is given. Technical men in the varied ceramic ware factories have found it mutually profitable to be federated in the one SOCIETY, and it should also profit the trade associations to be federated in the production researches. E.J.V.

State ceramic associations. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **7** [12], 345–46 (1928).—It is pointed out that in every state having a ceramic department there should be a state ceramic industries association with the single purpose of securing and using the research and educational facilities at its university in proportion to the relative industrial importance of the ceramic industries in that state. Ohio has such a state association and it has been finding ways of increasing and using the research facilities of its university. The results could have been obtained in no other way. E.J.V.

Missouri Ceramic Industries Association meeting. ANON. *Brick Clay Rec.*, **73** [11], 766–68 (1928); see also *Bull. Amer. Ceram. Soc.*, **7** [12], 376–78 (1928). E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **53** [618], 1932 (1928).—A report of the discussion on "Glassworks Refractories Materials" at the meeting held November 21, 1928. E.J.V.

Removing slag from tubes. ANON. *Arch. and Bldg.*, **60** [4], 133 (1928).—Where slag forms and bakes onto the lower row of tubes of water tube boilers, cold water is more effective for its removal than is steam. The cold water causes the slag to crack and fall off in large pieces. In these tests it was also found that freeing the tubes of slag increases the chimney draft, helps maintain high efficiency, and saves much money due to the time previously required for laying up and cleaning boilers. Now the cleaning is done while the boilers are in operation. During the cleaning process the temperature of the flue gases was reduced approximately 15°. The cold water was introduced into the boiler and onto the hot slag by means of an old-fashioned hand lance. But care must be exercised in introducing the cold water so that it will not touch the furnace walls. Cold water on a hot wall will crack the wall as readily as it will crack the slag. E.P.R.

Automatic coal burning machine. ANON. *Arch. and Bldg.*, **60** [4], 134 (1928).—The demand for an automatic coal burning device which would efficiently burn the cheaper grades of coal has resulted in the development of a new automatic stoker named the "Combustioneer" and manufactured by Combustioneer, Inc., Chicago. It is designed to feed coal automatically to the fire bed, by the underfeed principle, distributing the fuel evenly over the entire bed, eliminating air holes in the fire, insuring uniform combustion, and preventing blasts of air from impinging on the boiler. E.P.R.

Tool builders meet. ANON. *Abrasive Ind.*, **9** [12], 321 (1928).—Members and guests numbering 225 met at Skytop Lodge, Cresco, Pa., for the twenty-seventh annual convention of the National Machine Tool Builders' Assn. E.P.R.

Roofing Slate Association advertise industry. ANON. *Cement, Mill, and Quarry*, **33** [2], 76 (1928).—The Pa. Blue-Gray Roofing Slate Assn. is a corporation organized for the purpose of fostering, protecting, and promoting the welfare and interest of persons engaged in manufacturing roofing slate and the establishing of a greater demand for the sale of roof slate material. E.P.R.

Insulation of chimneys. ALFRED B. SEARLE. *Refract. Jour.*, **4** [37], 33 (1928).—The draft created by a chimney depends on the temperature of the gases passing through it and this temperature, in turn, depends on the heat absorbed by the brickwork of the chimney and lost by radiation. To ascertain precisely the losses which occur, is a matter of experiment aided by the use of mathematical formulas. Theoretically, the maximum draft of the chimney occurs with an average internal temperature of 303°C when the atmospheric temperature is 15°C. Many furnaces emit gases at a much higher temperature and so waste heat, but some (such as continuous kilns used in brickworks) emit gases at a temperature of only 120 to 200°C, which is much too low to make the best use of the chimney. For such works, the chimney must be very tall. If the gases enter the chimney with a temperature of 300°C and the atmospheric temperature is 20°C, the theoretical draft will be 1.13 in. water-gage, but if the gas has a temperature of only 150° with the atmospheric temperature 10°C, the draft will be 0.73 in. The colder the atmosphere, the greater will be the difference inside and outside the chimney and, therefore, the greater the draft. If the brickwork of the chimney absorbs much heat and passes it out by radiation, the temperature of the gases in the chimney will be correspondingly lowered, the "difference" will, therefore, be reduced still more and on a hot day the chimney may fail to draw. The loss of heat in a chimney with an average internal temperature of 300°C without insulation, is 2700 to 3600 B.t.u. per hour for every yard the chimney is high, whereas with a well-insulated chimney, the loss is only 1080 to 1440 B.t.u. per hour per yard. Hence, for a chimney 99 ft. high, the loss without insulation corresponds to 240 lbs. of good coal per day, and in an insulated

chimney to only 70 to 95 lbs. of coal per day. Chimneys connected directly to furnaces and therefore having a much higher internal temperature, lose a much larger quantity of heat by radiation. Some recent tests by S. show that insulating tall chimneys connected directly to furnaces emitting gases at 800°C effects a saving equal to 7 to 9% of the total fuel consumption. The hotter the interior of a chimney, the better will be the draft, so that an improvement in the draft-producing power is the principal result obtained by insulation. If the draft is already ample, the insulation should effect a saving in fuel. E.P.R.

Ohio Ceramic Industries Association. ANON. *Brick Clay Rec.*, **73** [11], 764–66 (1928); *Ceram. Ind.*, **11** [6], 604 (1928).—With an attendance of over 125 persons interested in ceramics, and with more interest and enthusiasm shown than ever before, the Ohio Ceramic Industries Assn. held its most successful meeting Nov. 2 and 3. The program revolved largely around the ceramic experiment plant in operation at Roseville, Ohio, which is proving itself a successful venture. F.P.H.

Bureau of Standard's report shows activity in ceramic industry. ANON. *Ceram. Ind.*, **11** [6], 567, 570–71 (1928).—A résumé is given of the activities of the Bureau of Standards during 1928 in the field of ceramics. F.P.H.

Ceramics, ceramists, and technical schools. L. HEIN. *Keramos*, **7** [22], T9 (1928). F.P.H.

Economic limit of high steam pressures. FUNK. POWER, **32** [10], 560 (1928); *Feuerungstechnik*, **16** [13], 155 (1928). F.P.H.

Factory floors. F. H. ROGERS. *Chem. and Ind.*, **47**, 1011–21 (1928).—The subject is extensively treated under the main headings: (1) ground floors, (2) raised or supported floors. For ground floors, the main considerations are the nature of the ground, and the kind of floor required, the weight it is to carry, and the use to which it is to be put. But away from the earth, a different set of conditions prevails, and one has to consider the floor below, height, lighting, etc. Physiological effects come from the nature, surface, resiliency, heat and sound transmission, and the color and general appearance of the floor material. Ceramic tiles or mosaic are used where cleanliness or absence of dust are desirable, as in food factories, offices, engine-rooms, or lavatories. Bitumen dressings, sparkless and acid-resisting, are used in explosive factories. Nonslip floors may be obtained by incorporating silicon-carbide or alundum dust in the material, and there is a large range of patent floorings having magnesite, asbestos, sawdust and iron filings mixed with the cement. H.H.S.

Waste heat in Japanese cement works. KASAI. *Chem. and Ind.*, **47**, 1027 (1928).—Manufacturers in Japan have adopted the use of waste-heat boilers to a considerable degree. In 18 of the 30 cement plants in that country, representing 80% of the total output, the recovery of waste heat is equivalent to a saving of 500,000 T. of coal per annum. H.H.S.

Glycerine ceramic compositions. W. F. DARKE AND E. LEWIS. *Chem. and Ind.*, **47**, 1073–92 (1928).—In a comprehensive review of the uses of glycerine the authors include: (1) Glycerine-litharge cements for luting, cementing, patching, producing coin impressions, blocks for printing, molds for electrotyping, and cementing ornamental stonework. These cements consist of equal parts of 70% glycerine and litharge; they are plastic for 10 minutes and set to a hard mass in 3 hours. (2) Ink removers from hectographic (copying) plates. The French Ministry of Public Works uses the following mixture: glue 10, glycerine 50, kaolin 2.5, water 37.5%. (3) Cosmetics, dentifrices, etc., containing glycerine with talc, clay, chalk, zinc oxide, etc. H.H.S.

Reform of the patent system. BRITISH SCIENCE GUILD. *Chem. and Ind.*, **47**, 1202 (1928).—The first recorded monopoly was granted by Henry VI of England to John of Utynam, a native of Flanders, to glaze the windows of King's Chapel at Eton and

Cambridge. From 1561 to the present day there is an unbroken system of English patent data, but despite the recent Patent Acts of 1907 and 1919, there is a growing dissatisfaction with the state of the law. The British Science Guild recommends a short-term patent (for 5 or 7 years) similar to the German "Gebrauchmuster," and makes it clear that the choice between this and a full-term patent should be with the patentee. Other recommendations deal with the protection of the poor inventor against a wealthy company by making threats actionable. The term "invention," the priority difficulty, and the abuse of "paper patents" or "intelligent forecasts," are discussed. H.H.S.

New fuel research laboratories at Ottawa. ANON. *Chem. and Ind.*, **47**, 1222 (1928).—An account of the $150,000 unit of the Division of Fuels and Fuel Testing of the Dominion of Canada Department of Mines. H.H.S.

Industrial accidents and infection. R. B. MORLEY. *Fisher's Machinery Guide*, **10** [11], 45 (1928).—Variation in the nature of claims that come before compensation boards is noted. During the month of October, infection cases were conspicuous. Men do not report minor accidents until infection has developed. About 10% of all accidents show infection in the early stages. H.H.S.

International Congress of Americanists. F. BOAS. *Science*, **68**, 361–64 (1928).—The 23rd Congress was held in New York, Sept. 19 to 21, 1928, with visitors from all over the world. Among the subjects discussed were Mexican ceramics, the influence of Spanish art on Indian art, cultural relations of Asia and America excluding the intervening Eskimo, the Eskimos, and the antiquity of man in America. The next congress will be held at Hamburg, Germany, in 1930. H.H.S.

Optical Society of America. ANON. *Science*, **68**, 372–73 (1928).—At the 13th annual meeting, held in Washington, Oct. 31 to Nov. 3, 1928, a group of papers was read on the psychology and biology of optics. Troland spoke on optics as seen by a psychologist, Hecht on the nature of the sensitivity to light, Laurens on the psychological effects of radiation, and Heyl on the physicist's idea of light. H.H.S.

A. H. Patterson obituary. O. STUHLMAN, JR. *Science*, **68**, 395–96 (1928).—Born Sept. 28, 1870, at Winston-Salem, N. C., educated at the Univ. of N. C. and at Harvard, he became successively professor of physics at the Univs. of Ga. and N. C., and was appointed dean of the School of Applied Science at N. C. in 1911. He died Sept. 9, 1928. H.H.S.

Czechoslovakian exposition. ANON. *Science*, **68**, 315 (1928).—In celebration of the tenth year of the existence of Czechoslovakia, an exhibition of contemporary culture and scientific achievement has been arranged at Brno, in Moravia. The exhibition is designed to show the progress made during the country's brief existence. H.H.S.

Return-tubular boiler defended. F. W. DEAN. *Power*, **68** [2], 57–59 (1928).—The return-tubular boiler, if properly designed, is safe, capable of good efficiency and high ratings, can be built in units of fair size, and is adaptable to modern conditions. Any failure in these respects is due to improper design. L.A.P.

Slow-speed vs. high-speed motors. B. A. BRIGGS. *Power*, **68** [2], 60–63 (1928).—B. shows that a high-speed motor with speed reducer is often cheaper and more efficient than a direct-connected low-speed motor. Speed is a prime consideration. L.A.P.

Technical excursion of the "Syndicat" to Marseilles and Provence. ANON. *La Céramique*, **30** [477], 517–37 (1927).—A description is given of a five-day technical excursion of the Syndicat des Fabricants de Produits Céramique de France. Five tile plants, four potteries, and a plant making enamels and colors were visited. A description of the plants is given and illustrated. A.E.R.W.

Foreign trade of the ceramic industry in France. ANON. *La Céramique*, **31** [480], 56 (1928).—The quantity in tons and the value in francs of the ceramic exports for France for 1927, 1926, 1925, and 1913 are given by industries. A.E.R.W.

Prevention of industrial accidents. M. FROIS. *La Céramique*, **31** [482], 93–100 (1928).—F. gives a detailed discussion of the social, financial, and other aspects of industrial accidents and industrial fatigue. The main causes are pointed out and the methods for prevention outlined. A.E.R.W.

Technical Congress of the French Society of Ceramic Manufacturers. ANON. *La Céramique*, **31** [484], 137–38 (1928).—An account is given of the Sixth Congress which was attended by members of the AMERICAN CERAMIC SOCIETY. A.E.R.W.

Ceramists' Tour Abroad. ANON. *La Céramique*, **31** [484], 169–73 (1928).—The speeches of Jean Berard, Paul Triquet, Léon Yeatman, André Baudet, M. Bokanowski, and the reply of M. C. Booze are given. A.E.R.W.

Official Laboratory, Technical Service of the Society, and Association of Technical Ceramic Instruction. JEAN BERARD AND V. BODIN. *La Céramique*, **31** [485], 185–87 (1928).—The functions and aims of the Official Laboratory of the Society of French Ceramic Mfrs., of the Technical Service, and of the Assn. of Technical Ceramic Instruction, all three of which have their headquarters in Paris, are described. A.E.R.W.

Work and operation of the Technical Service during 1927. V. BODIN. *La Céramique*, **31** [479], 21–23 (1928).—Seventy examinations of producers, driers, and furnaces were made and 16 inspection contracts drawn up. Plans have been made for collecting data on periodic kilns. Data obtained from a test of a porcelain kiln are given. The drying of several new clays was investigated; the conditions for decarbonating and dehydrating calcareous clays were studied. The exposition, courses of study, and financial situation are discussed. A.E.R.W.

Laboratory of the Society (French) and exposition of ceramic materials. ANON. *La Céramique*, **31** [485], 188–99 (1928).—Apparatus, machines, and new devices are described in detail and illustrated. A.E.R.W.

BOOKS

Waste Heat Engineering. Vol. 2. HANS BLACKE. Published by Oldenbourg, Berlin, 1928, 198 pp. 11.5 M. Reviewed in *Min. and Met.*, **9** [264], 567 (1928).—The constituent parts of plants for utilizing waste heat are described with the methods of assembling them and connecting them to the heat-producing and heat-utilizing apparatus. The methods of using waste heat in engines, furnaces, feed-water heaters, turbines, etc., are set forth. For review of Vol. 1, see *Ceram. Abs.*, **7** [7], 479 (1928). F.P.H.

History of Manufactures in the U. S., 1860–1914. Vol. II. VICTOR S. CLARK. Pp. xvi + 949, 10 plates. Carnegie Institution of Washington, Washington, D.C., 1928. Vol. I is out of print and the edition of Vol. II is very limited and no copies are for sale. They may be consulted at certain libraries, a list of which will be sent on application. The work is to be published for sale in 3 volumes, by the Mc Graw-Hill Book Co. H.H.S.

House Heating with Oil Fuel. P. E. FANSLER. 3rd. ed. Heating and Ventilating Magazine Co., New York. 366 pp., illustrated. Price $4.00. Reviewed in *Arch. and Bldg.*, **60** [4], 20 (1928).—The volume presents established facts and figures relating to the use of oil fuel in homes from the technical, practical, and economical viewpoint. Illustrations show many types of burners and heating plants. E.P.R.

Handbook of Combustion and Steam Boiler Plants. GEORG HERBERG. 447 pp. Julius Springer, Berlin, 1928. *Feuerungstechnik*, **16** [12], 142 (1928). F.P.H.

Blaster's Handbook. LAMOTTE. *Cement, Mill, and Quarry*, **33** [1], 55 (1928); for review see *Ceram. Abs.*, **7** [12], 875 (1928). E.P.R.

Estimating Building Costs. WILLIAM S. LOUNDES. 230 pp., illustrated. Price $3.00. **Specification Writing.** DAVID B. EMERSON. 75 pages and complete plans.

Price $1.00. Both published by International Textbook Co., Scranton. Reviewed in *Arch. and Bldg.*, **60** [3], 102 (1928).—These two publications are so closely related they are reviewed together. E.P.R.

Heating and Ventilation. H. REITSCHEL AND CHARLES W. BARABEE. McGraw-Hill Book Co., Inc., New York. 344 pp. 188 figures. Price $4.50. Reviewed in *Arch. and Bldg.*, **60** [3], 102 (1928).—This is the first English edition of the work and is translated from the 7th German edition. It is not, however, an exact translation but is rather a revision of the German text, giving those portions which are adaptable to American practice. E.P.R.

Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS
Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate

THREE INSTRUCTORS *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT — *Curriculum*—Ceramic Technology and Engineering

TWO INSTRUCTORS — *Founded 1923* — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering

TWO INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applied to ceramic manufacture

TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Founded 1926* — *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering — *Head of Department:* J. W. WHITTEMORE

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 — *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS

Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*

Founded 1927 — *Head of Department:* JOHN N. FRANK

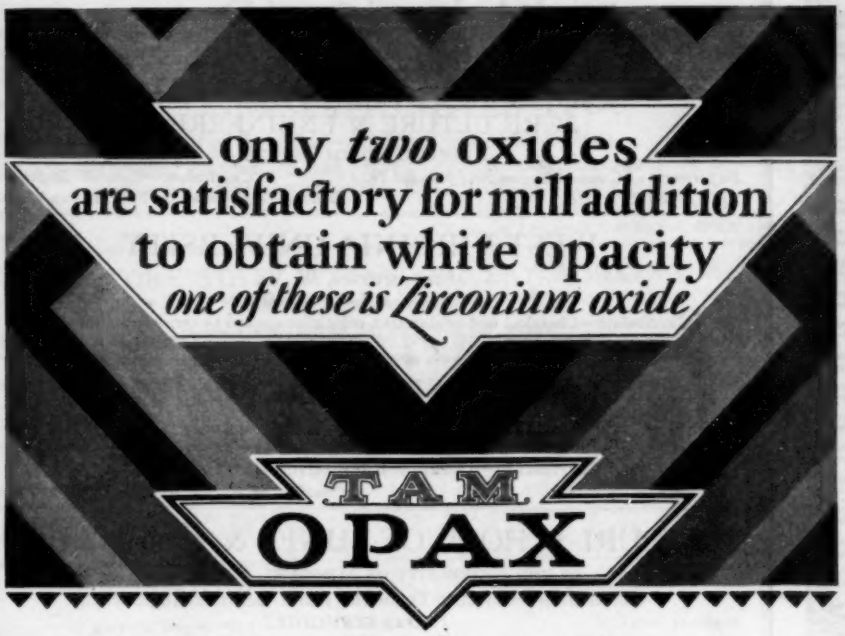
UNIVERSITY OF ALABAMA

UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

Curriculum—Technical ceramic courses given by Dept. of Chemistry and Metallurgy

TWO INSTRUCTORS — *Director:* STEWART J. LLOYD *Ceramics:* T. N. McVAY



is Zirconium Oxide with no admixtures.

No product has been prepared commercially by other than our patented processes with as high a Zirconium Oxide content or as high an Opacifying value as

OPAX

The Titanium Alloy Manufacturing Company
Ceramic Materials Division
6007 Euclid Avenue, Cleveland, Ohio

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MARION FOSDICK	Art	C. D. SPENCER, G. W. COOPER	Glass	H. E. DAVIS, F. S. SCHEPERS	Terra Cotta
H. G. WOLFRAM, W. N. HARRISON	Enamel	L. J. TROSTEL, C. F. GEIGER	Refractories	C. A. NICELY, G. A. BOLE	Heavy Clay Products
		H. P. HUMPHREYS, R. F. SHERWOOD	White Wares		

OFFICERS OF THE SOCIETY

M. C. BOOZE, President
Chas. Taylor Sons Co., Cincinnati, Ohio
R. R. DANIELSON, Vice-President
Metal and Thermit Corp., New York, N. Y.
H. B. HENDERSON, Treasurer
Standard Pyrometric Cone Co.
1538 N. High St , Columbus, Ohio
Ross C. PURDY, General Secretary and Editor
EMILY C. VAN SCHOICK, Assistant Editor
2525 N. High St., Columbus, Ohio

TRUSTEES

B. MIFFLIN HOOD
R. L. CLARE
B. T. SWEELY
J. C. HOSTETTER
G. W. DENISON
F. A. HARVEY
A. V. BLEININGER
E. DEF. CURTIS
E. C. HILL

Vol. 8 **February, 1929** **No. 2**

EDITORIAL

OUR FINANCIAL DEFICIT

The 1928 operations of this SOCIETY caused a deficit of $3929.54. It reduced the SOCIETY'S net resources to the 1926 figure. This was caused in part by depreciation in value of the *Bibliographies* and *Journal* numbers carried in stock and in part to a decreased income. This deficit was most largely due to three items: (1) the European tour, (2) the increased abstract publication, and (3) the large index.

European Tour There was no expectation of financial profit to the SOCIETY on account of the European tour. The advertising literature descriptive of the tour was issued in amounts and in character in proportion to the number of prospective tour reservations. Had every one been able to make the tour who had made plans to go, the SOCIETY would have realized enough to pay for the advertising issued.

The European tour was a worth-while investment both at home and abroad. The SOCIETY is stronger for having made this venture. The money expended was profitably spent. An evaluation of the profits realized would include the greatly enlarged personal and professional contacts; establishment of good-will and a cordiality in work programs

that can be had only through personal acquaintances. We now have a world-wide vision. The tour made the SOCIETY less provincial.

The Abstracts It was difficult to get started on the program of abstracting the published literature pertaining to ceramics. It has been a slow going task to learn how to gather the abstracts. The sources of the literature had to be ascertained and a corps of efficient abstractors organized. It is, however, worth all that it has cost in money and personal effort. It is satisfying to hear ceramic persons of notable achievements tell of the intrinsic value to them of *Ceramic Abstracts*.

The *Abstracts* have increased in quantity and quality beyond the SOCIETY'S budget expectation. More ample provisions will have to be made if the SOCIETY realizes fully from the increasing facilities which are being acquired in the securing of abstracts.

To keep abreast with the world's information on ceramic materials, products, processes, and general development is a very important factor in the success of ceramists, individually and collectively. Unless we ceramists individually and as a national group keep abreast with knowledge of world-wide development in our particular lines we shall soon be found wanting.

The progressive ceramist does not overlook the fact that there is a great deal that is adaptable and applicable common in all ceramic ware production. *Ceramic Abstracts*, which the SOCIETY publishes monthly and in December thoroughly indexed, makes available to each reader the development in all lines of ceramic manufacturing. This is worth all that it costs in money and labor. The SOCIETY should find means for letting the *Abstracts* develop to the fullest possible extent.

Larger Index If one would study the indexes for 1928 which appeared in the December number he would realize that they are a condensed statement of 1928 developments in ceramic art, science, and technology. There are, for the alert and capable, more inspirational topics listed in those indexes than could be elsewhere found.

The 1928 financial deficit should inspire the SOCIETY members to secure the funds with which to finance these profitable enterprises. The administration and work costs are in bounds of strictest economy and are fixed. The compiling and printing costs will increase with the increasing availability of information.

Rather than chagrin for the 1928 financial deficit there is pride for the increased information made known, classified, and indexed and for the increase in vision which the European tour has given.

ACTIVITIES OF THE SOCIETY

AMERICAN CERAMIC SOCIETY

Audit Report Year, 1928

Columbus, Ohio,
January 11, 1929

AMERICAN CERAMIC SOCIETY,
Columbus, Ohio

Gentlemen:

Following is my report on the audit of the accounts of the AMERICAN CERAMIC SOCIETY for the year ending December 31, 1928. Statements as follows are attached as a part of this report:

I. Statement of Assets and Liabilities, as of December 31, 1928.

II. Profit and Loss Statement for the year ending December 31, 1928.

Receipts of cash are promptly recorded and deposited in bank, and all payments are made by voucher check signed for the SOCIETY by the Treasurer and Secretary and countersigned by the President. Cash balances were verified and the securities examined. Inventories have been carefully taken and conservatively priced.

I hereby certify that it is my belief that this report correctly shows the financial operations of the AMERICAN CERAMIC SOCIETY for the year 1928 and the true financial condition at the close of the year.

Respectfully submitted,

A. L. PETERS,
Certified Public Accountant,
Member American Institute of Accountants

AMERICAN CERAMIC SOCIETY

STATEMENT I

Statement of Assets and Liabilities
(As of December 31, 1928)

ASSETS		
Cash in bank (general account)	$ 3,002.17	
Cash in revolving fund	300.00	$ 3,302.17
Liberty Bonds (par $9700)		9,861.00
Accounts receivable		1,773.20
Inventories		
Journals, 1918–1927	1,444.10	
Journals, 1928	233.20	
Transactions	572.50	
Collective Indexes	98.70	
Bibliographies	291.60	2,640.10
Office equipment		2,211.75
Total Assets		19,788.22
LIABILITIES AND SURPLUS		
Accounts or notes payable	None	
Deferred income		
Prepaid dues		
Divisions	$ 785.16	

STATEMENT I (*Continued*)

LIABILITIES AND SURPLUS			
Corporations	2,630.70		
Personal	5,409.80	8,825.66	
Prepaid *Journals*		1,182.29	
Net prepaid *Enamel Bibliography*		1,272.38	
Total deferred income (liabilities)			11,280.33
SURPLUS			
Balance December 31, 1927		12,437.43	
Less net loss for the year, 1928		3,929.54	
Surplus balance December 31, 1928			8,507.89

STATEMENT II

Profit and Loss Statement

(For the year ending December 31, 1928)

			Losses	Gains
Net *gain* on Divisions				$1,295.83
Collective indexes (sales)		34.93		
Decrease in inventory		3.60	.....	30.43
Journal, 1928 (sales)		3,969.81		
Advertising	$15,701.82			
Less commissions	1,190.65	14,511.17		
		18,480.98		
Printing (less inventory)	17,948.60			
Abstracts	1,812.05	19,760.65	1,279.67	.....
Journal, 1918–1927 (sales)	790.34			
Decrease in inventory		430.90	.....	359.44
Reprints (sales)		603.32		
Cost		1,089.99	486.67	.....
Seger's writings (sales)		90.00		
Cost		63.01	.....	26.99
Transactions (Sales)		200.00		
Cost		130.00	.....	70.00
Bibliographies (sales)		24.30		
Decrease in inventory		18.40	.....	5.90
European Tour expenditures		5,611.76		
European Tour income		2,861.36	2,750.40	.....
			4,516.74	1,788.59
Loss on above activities				2,728.15
			4,516.74	4,516.74
Above *loss* brought down				2,728.15
General income:				
Earned dues { Corporation		6,515.55		
Earned dues { Personal		16,179.90	22,695.45	
Interest income			520.45	
Miscellaneous income			73.21	
Total general income			23,289.11	

			Losses	Gains
General expenses:				
Salaries		13,908.62		
Office expense	Secretary 2,520.09			
	Editor 1,734.45			
	Other officers 47.68	4,302.22		
Rent		1,205.00		
Postage		1,821.67		
Traveling expenses		1,574.97		
Meeting expense	2,626.83			
Less booth rental	1,350.00	1,276.83		
Depreciation on office equipment		245.75		
Bad accounts written off		69.81		
Miscellaneous expenses		85.63		
Total general expenses			24,490.50	
Loss on general items				1,201.39
Net *loss* for the year 1928				3,929.54

NEW MEMBERS RECEIVED FROM DECEMBER 1 TO JANUARY 1

PERSONAL

Kenric H. Bird, 11 North Jefferson St., Chicago, Ill., Salesman, Norton Company, Worcester, Mass.

Harry O. Brawner, Bayard and Russel Sts., Baltimore, Md., Swindell Bros.

Charles William Death, No. 3, Kingscourt Flats, Todman Ave., Kensington, N.S.W., Australia, Assistant Works Manager, Crown Crystal Glass Co., Ltd., Waterloo, N.S.W.

J. R. French, Apartado 1402, Mexico City, Mexico.

Harvey R. Hiller, 122 S. Michigan Blvd., Room 1366, Chicago, Ill., District Sales Manager, Laclede Christy Clay Prod. Co.

William Irby, 21 Henry Ave., Lynn, Mass., Chemical Engineer, General Electric Co.

Gregory Jukovsky, Sadowaja 53, U.S.S.R. Tsjum, at Charkov, Technical Director of Glass Works; Prof. of the Silica Institute of Charkov.

C. J. Kinzie, Director of Research, Titanium Alloy Mfg. Co., Niagara Falls, New York.

Randal K. Robertson, 1174 Phillip Place, Montreal, Quebec, Works Manager.

William Ernest Ross, 217 E. Ontario St., Chicago, Ill., Hull House Kilns Inc., 800 S. Halsted St., Chicago, Ill.

H. Salmang, Institut für Gesteinshüttenkunde, Aachen, Germany.

Seigo Takahara, 246 Ogone-cho Higashi-Ku, Nagoya, Japan, Engineer for Nippon Toki Kabushiki Kaisha.

William M. Taylor, 56 Acton Rd., Columbus, Ohio, Test and Demonstration Engineer for the Logan Gas Co., Logan, Ohio.

Granville G. Westerfield, 112 Spencer Ave., Indianapolis, Ind., Manufacturer and Mechanical Engineer.

STUDENTS

Guy V. Harris, Univ. of N. C., Raleigh, N. C.

Joseph McGregor Higgins, Univ. of Toronto, Toronto, Can.

Robert E. Lee, Mo. School of Mines & Metallurgy, Rolla, Mo.

James Sutherland Little, Univ. of Toronto, Toronto, Can.

R. J. Powell, Ga. School of Technology, Atlanta, Ga.

F. R. Stone, Univ. of Toronto, Toronto, Can.

H. L. Watts, Jr., University of Toronto, Toronto, Can.

Membership Workers' Record

	Personal		Student
D. F. Albery	1	C. M. Dodd	1
E. R. Berry	1	A. F. Greaves-Walker	1
M. M. French	1	A. V. Henry	1
Seiji Kondo	1	R. J. Montgomery	4
R. D. Landrum	1		
H. B. Lindsay	1	Total	7
C. B. McComas	1	Grand Total	21
Z. I. Perkal	1		
F. Singer	1		
Office	5		
Total	14		

LOCAL SECTION MEETINGS

Pittsburgh Section

The January meeting of the Pittsburgh Section was held January 8 at the Mellon Institute. Arthur E. Baggs of the Ceramic Art Department of Ohio State University addressed the meeting on the subject of "Art in Ceramics."

The following were among those present:

Drury D. Turner, Robert C. Boyd, and Dallas R. Johnston, Standard Sanitary Mfg. Co.
Herbert S. Kirk, R. M. Russel, J. V. Bowman, R. E. Reif, and W. Keith McAfee, Universal Sanitary Mfg. Co.
H. M. Kraner, Westinghouse Co.
P. D. Helser, Eljer Co.
Wm. E. Rice, U. S. Bureau of Mines.
R. F. Ferguson, Dean S. Hubbell, S. M. Swain, G. R. Daniel, G. K. Lowe, S. S. Cole, and S. M. Phelps, Mellon Institute.
Hascall DuBois and F. G. Lord, Pennsylvania Pulverizing Co.
F. A. Harvey, Harbison-Walker Refractories Co.
Alexander Silverman, Univ. of Pittsburgh
Irene J. Betterbender, Langley High School
Roy E. Swain, Charleroi, Pa.
Katherine Malcom, Carnegie, Pa.
Grace Milliken, Pittsburgh, Pa.

Michigan-Northwestern Section

The members of the Michigan-Northwestern Section held a meeting at the Savoy Hotel on the evening of January 15. Gordon Klein, Assistant Works Manager, New Castle Refractories Company, New Castle, Pa. was the speaker for the evening.

NOTES AND NEWS

CERAMIC SCHOOL NOTES

Heavy Products Short Course at Iowa State College[1]

The annual short course for heavy products men was held in the auditorium of Engineering Hall at Iowa State College, January 9 to 12. Thirty-five men registered for the course which is the largest number yet gathered for such a course. A few men came from outside of the state which is also a development of interest. While the

[1] By Paul E. Cox.

engineering short courses of all sorts are under the direction of the Engineering Extension Department, the task of making up the program and the management during the week fell to D. A. Moulton, of the Department of Ceramic Engineering.

John C. Boss, of Elkhart, Indiana, was on a business trip into Iowa and stopped off for the course. He replaced Professor Moulton for the topic, "Modernizing Plant Driers," and since both H. R. Straight, of Redfield, Iowa, and S. I. Zook, of Des Moines, have developed improvements in driers, a lively discussion was developed and underneath the froth much solid material could be gotten by the clay products men and even more by the students of the department who were present. The froth of course was the fun men have with one another when they do not agree on methods.

From papers delivered by men on the faculty of Iowa State College the most good was derived from the paper by Henry Giese, of the Department of Agricultural Engineering. He is doing research work on the use of hollow tile for farm buildings and has learned that buildings of the silo type are best suited for storage of both seed corn and corn on the cob. Additionally, he has solved the problem of making up designs for farm buildings which include these silo forms and at the same time he is able to create buildings that are beautiful, satisfactory in first cost, and of the greatest permanence. Since work like his promotes sales of clay products his paper was very satisfying. Incidentally the College believes in his ideas, for his type of structure is to be used for the purposes named.

The blizzard that developed just before the course started undoubtedly kept the enrolment down, and with good weather another year the enrolment should run up to excellent figures.

Research at Illinois

The Clay Products Association has entered into an agreement with the University of Illinois whereby the Department of Ceramic Engineering of that institution will undertake research on several projects which are of importance to the manufacturers of sewer pipe. The Association has appropriated $6000 for the work which is to be done at the University during the next twelve months.

The Department is already engaged on several coöperative investigations which include research on vitreous enamels for metals; the effect of the gases of combustion upon the properties of such enamels; the drying of clay wares, particularly building brick; the study of the slagging of fire brick; the study of porcelain for high tension insulators; the study of the properties of feldspar as a material for pottery. These projects are being financed by associations or firms to the amount of over $28,000.

A large part of the value of such investigations lies in the training of young men in research for the industries and several graduate students are so engaged.

SOCIETY OF GLASS TECHNOLOGY

The Society of Glass Technology met in Stourbridge on November 20 and 21, 1928. On the evening of November 20 the President, Walter Butterworth, Sr., lectured on "Byzantine, Saracenic, and Venetian Glass." In the production of artistic glass, the outstanding periods are the Egyptian, Roman, Byzantine, and Saracenic, Venetian, German, French, and the modern, in which English flint glass occupies a worthy place. Probably the Venetian was the most brilliant of all these, and the Byzantine and Saracenic period preceded it. Venice held pride of place in the production of artistic glass for several centuries. She drew much knowledge from Egypt, Rome, Constantinople, and Damascus.

The Byzantine Empire, 330–1453, founded by Constantine with its capital, Constantinople, had a troubled and chequered history. Constantine encouraged arts and industry, attracted skilled artists and workers, including glassmakers who became numerous, occupying the quarter near the "Gateway of Glass." Their glassware soon commanded export to Alexandria, Persia, etc.

Enamel painting on glass was apparently begun by Greeks under Byzantine rule.

In the 7th Century the Arabs conquered Syria and Egypt, and Spain in the 8th Century, and oriental influences spread westward. Saracen glass coins and weights were in use, some being stamped with the names of Caliphs from 720 to 1225. The glass factories at Damascus became famous, and this fame lasted until the 14th Century.

In the 15th Century the manufacture of beautiful glass passed to Venice. Glassmaking was carried on much earlier in Venice, and so great was the extent of the manufacture of mosaics and beads, that in 1292 the Grand Council ordered the removal of all glass works to Murano. The Guild of Glass Blowers was already formed, and processions were organized to display the fine glasses made. The city regarded the industry as the "apple of her eye" and repressive laws were passed to keep it within her power. Drastic measures were taken to prevent emigration of workers, and workshop regulations were stringent. Four categories of glass were made: (1) canes for beads, (2) canes for pearls and enamels, (3) hollow ware and general, (4) window and plate glass. Each section had its guild, and the State kept a "Libro d'Oro," skilled workers being regarded as a class of nobility.

Following the suggestion of Marco Polo, the great Venetian traveler, a considerable export trade was obtained.

During the first half of the 16th Century, Venetian glass reached its zenith for incomparable craftsmanship, grace, lightness, and delicacy of form. It was a triumph of blown glass of a thin, delicate type tending toward the fantastic. The variety of the graceful glasses was astonishing, and a great trade was done with Europe, Asia, and the far East.

The tendency to let the playful fancy of the craftsman run riot was, in time, to undermine the fine qualities of Venetian glass. In the effects of filigrano, millefiori, and latticinio, the ability of the Venetians seemed to have no limit. Show pieces of the exquisite work were exhibited in guild processions, etc., and the fame of this work influenced the course of glass manufacture in other countries.

After the 16th Century foreign competition from France, Bohemia, Germany, the Netherlands, and England, dealt a severe blow to Venice whose craftsmen had at last carried away her secrets. In the 17th Century English cut lead flint glass became the rage, ousting Venetian and Bohemian styles. The florid style of Venetian glass remained in favor for some time, and usually specimens of this period are found in museums. Political circumstances contributed toward the decline of the Murano craft in the 18th Century, and by 1806 the number of glass works had decreased to twelve.

At the present a vigorous trade has again arisen, but it is only a shadow of the former grandeur.

On November 21, the meeting was devoted to "Glassworks Refractory Materials." The discussion was initiated by W. E. S. Turner who spoke on "Recent Progress in the Study of Refractory Materials." He referred at the outset to the work of the Refractories Committee of the Society of Glass Technology and to the general report (drawn up by W. J. Rees the Chairman of the Committee) which has been published. Prof. Turner stated the most important problems awaiting solution and referred at some length to work which had been done by the German Society of Glass Technology.

The results of the two independent sets of investigations showed a good deal of concordance. Particulars were given of a number of British and German clays of various compositions and types. Clays rich in alumina are more resistant to the action of a lead batch than are clays with a lower alumina but a higher silica content. Similar results are obtained with soda-lime-silica, and with opal glass batches. Clays with high ferric oxide content are less resistant to corrosion than those with low ferric oxide values. Sodium sulphate is the one raw material to which highly siliceous clays were more resistant than the highly aluminous clays. Emphasis was laid upon the greater importance of porosity on the properties and behavior of the glass. Clays with high porosity were most susceptible to attack. High temperature firing of refractory materials for the glasshouse was most important. Clays with high alumina content were better for nearly all purposes than were clays of low alumina content, provided the clays were given adequate firing.

Professor Turner also referred to investigations on the tensile strength and expansion

of glasshouse refractories by J. F. Hyslop and his colleagues at the Research Laboratories of the General Electric Co., Ltd., at Wembley.

J. F. Hyslop supplemented Professor Turner's remarks and gave some details of his experiments. He pointed out that the composition of the material is important. With light or moderate firing it is possible that siliceous refractory materials might give results superior to aluminous materials. All the indications, however, are that the best possible results are obtainable only by using materials of high alumina or mullite content which have been adequately fired.

The following reports were also communicated.

(*a*) "A Summary of Faults and Defects which May Arise in the Manufacture and Use of Glasshouse Pots; Their Cause and Prevention," by Percival Marson.

(*b*) "The Durability of Glasshouse Pots," by J. F. Hyslop.

(*c*) "Memorandum on the Purification of Clay Heat-Treatment of Pots and the Use of Sillimanite Pots," by W. E. S. Turner.

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY (Annual Meeting)	Feb. 4–9, 1929	Chicago, Ill.
American Concrete Institute (Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Face Brick Assn.	Feb. 4–9, 1929	Chicago, Ill.
American Refractories Institute	Feb. 4–9, 1929	Chicago, Ill.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Association of Grinding Wheel Mfrs.	Feb. 6–7, 1929	Chicago, Ill.
Assn. of Scientific Apparatus Makers of America	May 3, 1929	Los Angeles, Calif.
Common Brick Mfrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Assn. of Mfrs. of Heating and Cooking Appliances	May 8–9, 1929	New York City
Natl. Brick Mfrs. Assn.	Feb. 4–9, 1929	Chicago, Ill.
Natl. Paving Brick Mfrs. Assn.	Feb. 13–15, 1929	Washington, D. C.
Structural Clay Tile Assn.	Feb. 4–9, 1929	Chicago, Ill.

Our 1928 and 1929 Membership Records

Invite a Member

You will be helping yourself as well as your fellow-worker when you invite him to become a member of

The AMERICAN CERAMIC SOCIETY

The record for 1928 is given below. We must improve this in 1929

Month	Personal	Corporation
Jan.	2203	309
Feb.	2248	309
March	2281	310
April	2302	311
May	2306	311
June	2308	312
July	2281	312
August	2286	311
September	2212	209
October	2226	312
November	2245	315
December	2262	315

INVITE A MEMBER

The American Ceramic Society
2525 North High Street,
Columbus, Ohio

U. S. Rotary Enamel Smelting Furnaces Give

SATISFACTION

Excellent Results Best Demonstrated by Large Number of Repeat Orders

Crane Enamelware Company, Chattanooga, Tennessee.
Kohler Company, Kohler, Wisconsin.
Porcelain Enamel & Mfg. Company, Baltimore, Md.
Ingram-Richardson Mfg. Company, Frankfort, Ind.
Ingram-Richardson Mfg. Company, Beaver Falls, Pa.
Ingram-Richardson Corporation, Bayonne, N. J.
Grand Rapids Refrigerator Co., Grand Rapids, Mich.
Columbian Enameling & Stamping Co., Terre Haute, Ind.
Sheet Metal Products Company, Toronto, Canada.
Republic Metalware Company, Buffalo, N. Y.
Pacific Sanitary Mfg. Company, Richmond, California.
A. Weiskittel & Son Company, Baltimore, Md.
Malleable Iron Range Company, Beaver Dam, Wis.
Edison Electric Appliance Co., Inc., Chicago, Ill.
Welsh Tinplate & Metal Stpg. Co., Ltd., Llanelly, England.
Ernest Stevens, Limited, Cradley Heath, England.
Ward Leonard Electric Company, Mount Vernon, N. Y.
American Enameled Products Co., Chicago, Ill.
Michigan Porcelain Tile Works, Ionia, Michigan.
Stanley Insulating Company, Great Barrington, Mass.
Roesch Enamel Range Company, Belleville, Ill.
L. D. Caulk Company, Milford, Delaware.

SIZES AND CAPACITIES

No 1	No. 2	No. 3	No. 4	No. 4-B
60 lb.	150 lb.	350 lb.	750 lb.	1200 lb.

Description, Photographs, Specifications and Prices Mailed promptly

THE U. S. SMELTING FURNACE CO.

BELLEVILLE, ILLINOIS, U. S. A.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE

A

Air Reducing Valves
Fisher Governor Co.

Air Traps
Fisher Governor Co.

Alumina (Hydrate and Calcined)
Harshaw Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

Aluminum Oxide (Fused)
The Exolon Co.
Harshaw Fuller & Goodwin Co.

Aloxite (Refractory Products)
The Carborundum Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
Harshaw Fuller & Goodwin Co.

Ammonium Carbonate
Harshaw Fuller & Goodwin Co.

Antimony Oxide
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Auger Machines
Chambers Brothers Co.

Automatic Control Valves
Maxon Premix Burner Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.
Leeds & Northrup Co.

B

Back-Pressure Valves
Fisher Governor Co.

Ball Mills (Laboratory Type)
Abbé, Paul O.

Ball Mills
Abbé, Paul O.
McDanel Refractory Porcelain Co.
Mueller Machine Co., Inc.

Barium Carbonate
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Barytes
Harshaw Fuller & Goodwin Co.

Batts
The Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. (*"Alundum-Crystolon"*)

Bitstone
Eureka Flint & Spar Co.
Golding Sons Company
Harshaw Fuller & Goodwin Co.
Potters Supply Co.

Blocks (Refractory)
The Carborundum Co.
Norton Co.

Blowers (Centrifugal, High Pressure)
Maxon Premix Burner Co. (*Premix*)

Boats, Combustion
Norton Co.

Boiler Feeders
Fisher Governor Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Pacific Coast Borax Co.
Roessler & Hasslacher Chemical Co.

Boric Acid (Anhydrous)
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Pacific Coast Borax Co.

Borax Glass
Harshaw Fuller & Goodwin Co.
Pacific Coast Borax Co.

Brickmaking Machinery
Chambers Brothers Co.

Bricks (Refractory)
Harbison Walker Refractories Co.
Norton Co. (*"Alundum-Crystolon"*)
The Carborundum Co. (*"Carbofrax Aloxite"*)

Heavy Duty Refractories
for the Whole Ceramic Industry

FUSED ALUMINA

Sold under the trademark "Alundum"

Bricks, Plates and Combustion Chambers
Enameling Muffles
Tunnel Kiln Muffles
Burner Blocks
Grain for improvement of Sagger Mixtures
Grain for addition to Porcelain Bodies
Glass Tank Blocks
Saggers
Cements

SILICON CARBIDE

Sold under the Trademark "Crystolon"

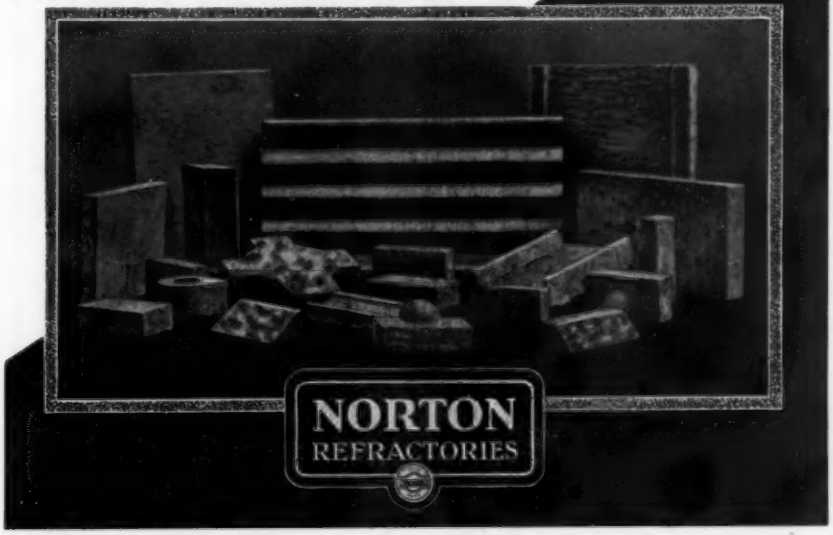
Bricks
Rectangular Plates
Hearth Plates
Tunnel Kiln Car Tops
Saggers
Grain for Retort Bodies
Grain for improvement of Crucible Mixtures
Cement

MAGNESIA (ELECTRICALLY FUSED)

Bricks
Cements for tamping and ramming
Furnace Linings for Melting Furnaces, both ferrous and non-ferrous
Crucible Linings
Casting Tubes
Cement

NORTON, COMPANY, Worcester, Mass.
New York Chicago Cleveland

VISIT OUR BOOTH, NO. 124, at the Ceramic Show and see the new Norton motion picture film, "The Handling of Heat," from which this illustration was taken.



BUYERS' GUIDE (continued)

C

Carbofrax (Refractory Products)
The Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbonates (Barium, Lead)
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler & Hasslacher Chemical Co.

Caustic Soda
Harshaw Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.

Cements
Corundite Refractories Co.
Harbison Walker Refractories Co.
Norton Co.
The Carborundum Co.

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harbison Walker Refractories Co.
Harshaw Fuller & Goodwin Co.
Metal & Thermit Corp.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Harrop Ceramic Service Co.
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.

Chromium Oxide
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

China Clay (Georgia)
Golding Sons Company

Clay (Ball)
Golding Sons Company
Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.
United Clay Mines Corp.

Clay (Electrical, Porcelain)
Edgar Brothers Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Enamel)
Edgar Brothers Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.
Vitro Mfg. Co.

Clay (Fire)
Corundite Refractories Co.
Edgar Brothers Co.
Golding Sons Co.
Harbison Walker Refractories Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
United Clay Mines Corp.

Clay (Potters)
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Sagger)
Edgar Brothers Co.
Golding Sons Co.
Harbison Walker Refractories Co.
Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Stoneware)
United Clay Mines Corp.

Clay Tests
Harrop Ceramic Service Co.

Clay (Terra Cotta)
United Clay Mines Corp.

Clay Handling Machinery
Mueller Machine Co., Inc.
W. S. Tyler Co.

Clay Miners
Edgar Brothers Co.
Golding Sons Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (German Vallendar)
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Clay (Wad)
Golding Sons Co.

The National Silica Co.

OREGON, ILL.

Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica **140 Silk Lawn Test**

SERVICE TO POTTERS

We Manufacture—

- PINS
- STILTS
- THIMBLES
- SPURS
- SAGGERS
- CRUCIBLES
- TILE for Decorating Kilns

We Sell—

- BALL CLAY
- SAGGER CLAY
- WAD CLAY
- GROUND FIRE CLAY
- BITSTONE
- FIRE BRICK
- IMPORTED PARIS WHITE
- DOMESTIC WHITING

THE POTTERS SUPPLY COMPANY

EAST LIVERPOOL, OHIO

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay (Wall Tile)
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.
United Clay Mines Corp.

Clay Washing Machinery
Mueller Machine Co., Inc.

Clay Working Machinery
Mueller Machine Co., Inc.

Cloth (Wire Bolting)
W. S. Tyler Co.

Cobalt Oxide
Drakenfeld and Co., B. F.
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Colors
Drakenfeld and Co., B. F.
Harshaw Fuller & Goodwin Co.
Hommel Co., O.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Combustion Apparatus
Leeds & Northrup Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

Cones (Filter)
Norton Co.

Conveyors (Clay, Sand, Brick, etc.)
Mueller Machine Co., Inc.
Philadelphia Drying Machinery Co.

Controllers
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Cores (Alundum Furnace)
Norton Co.

Cornwall Stone
Eureka Flint & Spar Co.
Harshaw Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.
Roessler and Hasslacher Chemical Co.

Cornwall Stone (Imported)
Golding Sons Company
Harshaw Fuller & Goodwin Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crushers
Chambers Brothers Co.
Mueller Machine Co., Inc.

Cryolite
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

D

Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Disks (Alundum, Porous, Filter)
Norton Co.

Dishes (Alundum, Filtering, Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.
Mueller Machine Co., Inc.

Dolomite
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.

Driers
Harrop Ceramic Service Co.

Driers (China Ware, Porcelain)
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

Drying Machinery
Philadelphia Drying Machinery Co.
Proctor & Schwartz, Inc.

E

Electrical Instruments
Brown Instrument Co.
Leeds & Northrup Co.

Electrical Porcelain Machinery
Mueller Machine Co., Inc.

Enamels
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Enameling Equipment, Complete
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.

PENNSYLVANIA PULVERIZING CO.
LEWISTOWN, PA.

Pure Canadian Potash Feldspar
Potters Flint Placing Sand

SALES OFFICE
323 Fourth Avenue
Pittsburgh, Pa.

THE VITRO MFG. CO. TRADE MARK PITTSBURG, PA.

Laboratory Control Guarantees Uniformity

Every step in the manufacture of Vitro Products is under direct and constant laboratory control. This gives you products of absolute uniformity and complete freedom from undesirable impurities. Vitro Products give Specified Results.

Write for prices and full information

Products of
Vitro Manufacturing Co.
Vitrifiable Colors
Chromium Oxide
Cadmium Sulphide
Selenium
Sodium Uranyl Carbonate
Sodium Uranate
Sodium Antimonate
Copper Oxide
Zirconium Products
Cobalt Oxide
Cement Colors
Roman Gold
White Gold
Enamels for Cast Iron
Enamels for Sheet Steel
Porcelain Sanitary Enamels
Copper Enamels

THE VITRO MANUFACTURING CO.
Fulton Bldg., PITTSBURGH, PA.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Enameling Furnaces
Chicago Vitreous Enamel Product Co.
Corundite Refractories Co.
Ferro Enamel Supply Co.
The Carborundum Co. (*Carboradiant*)
U. S. Smelting Furnace Co.
Vitro Mfg. Co.

Enameling Muffles
The Carborundum Co. (*Carbofrax*)

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Engineering Service
Chambers Brothers Co.
Harrop Ceramic Service Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.

Exhaust Relief Valves
Fisher Governor Co.

Exolon (Refractory Products)
The Exolon Co.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Fans
Philadelphia Drying Machinery Co.

Feldspar
Erwin Feldspar Co.
Eureka Flint & Spar Co.
Genesee Feldspar Co.
Golding-Keene Co.
Golding Sons Co.
Harshaw Fuller and Goodwin Co.
Innis, Speiden & Co. (*Isco*)
Pennsylvania Pulverizing Co.
River Feldspar Co.
Roessler and Hasslacher Chemical Co.
Standard Flint & Spar Co.
United States Feldspar Corp.

Filter Cloth (Wire)
W. S. Tyler Co.

Filtering Machinery
Mueller Machine Co., Inc.

Fire Brick
Corundite Refractories Co.
The Carborundum Co.
Harbison Walker Refractories Co.

Flint
Eureka Flint & Spar Co.
Golding-Keene Co.
Golding Sons Co.
Harshaw Fuller and Goodwin Co.
Innis, Speiden & Co. (*Carrara*)
National Silica Co.
Pennsylvania Pulverizing Co.
Roessler and Hasslacher Chemical Co.
Standard Flint & Spar Co.

Flint (American Sand and Rock)
Golding Sons Company

Flint (Imported French)
Golding Sons Company

Flint Pebbles
Eureka Flint & Spar Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Flow Meters
Brown Instrument Co.
Leeds & Northrup Co.

Frit
Vitro Mfg. Co.

Furnaces
Chicago Vitreous Enamel Product Co.
Corundite Refractories Co.
Ferro Enamel Supply Co.
Harrop Ceramic Service Co.
The Carborundum Co. (*Carboradiant*)
U. S. Smelting Furnace Co.

Furnaces (Electrical Laboratory Type)
Engelhard, Chas., Inc.

Furnace Slabs
Corundite Refractories Co.

G

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Ferro Enamel Supply Co.
Harshaw Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Glaze and Body Spar
Golding Sons Company
Harshaw Fuller & Goodwin Co.

Glaze Spar
Erwin Feldspar Co.
Eureka Flint & Spar Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Gold
Drakenfeld & Co., B. F.
Harshaw Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Guards (Safety)
W. S. Tyler Co.

H

Hearths
The Carborundum Co.
(*Carbofrax* heat treating)

H. W. R. SAGGER CLAY
and
H. W. R. —D— CLAY

For Your Complete Sagger Batch

Write for Complete Information

HARBISON-WALKER REFRACTORIES CO.
World's Largest Producers of Refractories
Pittsburgh, Pa., U.S.A.

Offices in Principal Cities

BORAX *Guaranteed 99½%–100% Pure* **BORIC ACID**

Select the Brand which has back of it years of *successful use* by experienced Ceramists

Pacific Coast Borax Co., New York

Chicago 20 **Los Angeles**

Refractory Materials
Products of the Electric Furnace

SILICON CARBIDE
SILICON CARBIDE FIRESAND
FUSED SILICA
ARTIFICIAL MULLITE
FUSED ALUMINUM OXIDE
FUSED MAGNESITE

Furnished in raw material form, ground to meet specifications.

Our Research Department with fully equipped laboratories is always at your service.

WRITE US ABOUT YOUR PROBLEMS

THE EXOLON COMPANY
Established 1914

Electric Furnace Plants { THOROLD, ONTARIO / STAMFORD, ONTARIO

Finishing Plant / General Offices } BLASDELL, N. Y.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
The Carborundum Co.

Humidity Control
Brown Instrument Co.
Leeds & Northrup Co.

Hydrogen Ion Equipment
La Motte Chem. Products Co.
Leeds & Northrup Co.

Hygrometers
Brown Instrument Co.

I

Indicators & Recorders (Steam, Air, Gas)
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Indicators, Chemical
La Motte Chem. Products Co.
Leeds & Northrup Co.

Infusorial Earth
Innis, Speiden & Co.
Harrop Ceramic Service Co.

Instruments (Temperature, Pressure)
Brown Instrument Co.
Leeds & Northrup Co.

Iron (Enameling)
American Rolling Mill Co.

J

Jiggers
Mueller Machine Co., Inc.

K

Kaolin
Edgar Brothers Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.
United Clay Mines Corp.

Kaolin (Delaware)
Golding Sons Company

Kilns
Harrop Ceramic Service Co.

Kilns (China, Decorating)
Drakenfeld & Co., B. F.

Kryolith
Harshaw Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

L

Laboratory Supplies
W. S. Tyler Co.

Lawn
W. S. Tyler Co.

Leers (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
The Carborundum Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Corundite Refractories Co.
Harbison Walker Refractories Co.
Norton Co.
The Carborundum Co.

Liquid Level Indicator and Recorder
Brown Instrument Co.
Fisher Governor Co.
Leeds & Northrup Co.

M

Magnesia (Sintered, Calcined)
Harbison Walker Refractories Co.
Roessler & Hasslacher Chemical Co.
The Exolon Co.

Magnesite
Drakenfeld & Co., B. F.
Harbison Walker Refractories Co.
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler & Hasslacher Chemical Co.

Manometers
Brown Instrument Co.

Manganese
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Meters (All Kinds)
Engelhard, Chas., Inc.

Minerals
Drakenfeld & Co., B. F.
Erwin Feldspar Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Motors
Harrop Ceramic Service Co.

MONTGOMERY MULLITE
PYROMETER PROTECTION TUBES

Made of Electrically Fused and Chemically Controlled Mullite

★ SUPER-REFRACTORY ★ IMPERVIOUS ★ RIGID ★

The Ultimate in High Temperature Pyrometer Protection Tubes

Distributed by These Leading Pyrometer Instrument Manufacturers

LEEDS & NORTHRUP Co., Philadelphia, Pa. THE BRISTOL Co., Waterbury, Conn.

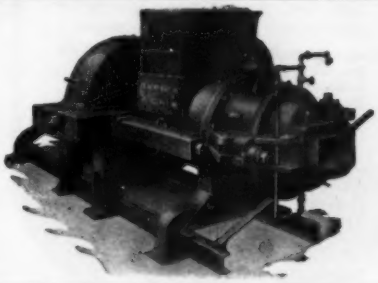
MONTGOMERY PORCELAIN PRODUCTS CO.

FRANKLIN, OHIO, U. S. A.

Brick Making Machines

Crushers Grinders Mixers

Automatic Cutters



Chambers Bros. Co.

Philadelphia Pennsylvania

EUREKA FLINT & SPAR Co.

MINERS, IMPORTERS AND PULVERIZERS

Pure English Cornwall Stone

Imported French Flint	Eureka #1 Feldspar
French Placing Flint	Connecticut Feldspar
American Rock Flint	New Hampshire Feldspar
American Sand Flint	New York Feldspar

Eureka Specially Selected Glaze Spar has been famous for Twenty Years for its Brilliant Lustre

EUREKA FLINT & SPAR CO.

INCORPORATED

Trenton-New Jersey

BUYERS' GUIDE (continued)

Muffles (Furnace)
Corundite Refractories Co.
Norton Co.
The Carborundum Co. (*Carbofrax*)

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Harshaw Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

N

Nitrates (Cobalt, Sodium)
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler & Hasslacher Chemical Co.

O

Opacifiers
Harshaw Fuller & Goodwin Co.
Titanium Alloy Mfg. Co.

Orifice Plates
Brown Instrument Co.

Oxides
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

P

Pans (Wet and Dry)
Chambers Brothers Co.
Mueller Machine Co., Inc.

Pebble Mills
Abbé, Paul O.
Mueller Machine Co., Inc.

Pins
Potters Supply Co.

Placing Sand
Eureka Flint & Spar Co.
Golding Sons Co.
National Silica Co.
Pennsylvania Pulverizing Co.
Roessler & Hasslacher Chemical Co.
United Clay Mines Corp.

Plant Design
Harrop Ceramic Service Co.

Plate Feeders
Chambers Brothers Co.

Plate (Filter)
Norton Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Supply Co.
Roessler & Hasslacher Chemical Co.
Vitro Mfg. Co.

Potash (Carbonate)
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Potassium Bi-fluoride
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler & Hasslacher Chemical Co.

Pottery Machinery
Mueller Machine Co., Inc.

Pug Mills
Chambers Brothers Co.
Mueller Machine Co., Inc.

Pulverizing Machinery
Abbé, Paul O.
Mueller Machine Co., Inc.

Pulverizing Mills
Abbé, Paul O.
Mueller Machine Co., Inc.

Pumps
Mueller Machine Co., Inc.

Pump Governors
Fisher Governor Co.

Pyrometers (Indicating)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometers (Optical)
Leeds & Northrup Co.

Pyrometers (Recording)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer (Switches)
Brown Instrument Co.
Engelhard Chas., Inc.
Leeds & Northrup Co.

Pyrometer Thermocouples
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Corundite Refractories Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Genesee Feldspar

Highest Grade Canadian Feldspar
Uniform Quality-Unlimited Quantity

Dependable!

In Selecting and Adopting Feldspar

Be Sure* to Secure the Product from a *Dependable Source of Large Extent.

We Control and Operate our Own Mines in Ontario, reported by Canadian Engineers to be the Largest Deposits of the Highest Grade Spar in Canada.

Users of GENESEE SPAR can, therefore, feel sure of Increased Profit, through receiving over a Long Period of Time an Unblended Uniform Quality of the Highest Grade Canadian Potash Feldspar.

Each shipment is tested before it leaves our Mill; if desired, we furnish our customers with the Chemical and Physical Analysis on each and every shipment.

Send for Information, Analysis and Sample

GENESEE FELDSPAR CO., INC.
Formerly Pennsylvania Feldspar Co.
Rochester, New York

LUSTERLITE ★ ENAMELS

EXCELLENCE to a greater degree than ever before marks the LUSTERLITE line. Enlarged facilities and improved equipment assure prompt and efficient service in supplies and equipment for the Enameling Industry.

Chicago Vitreous Enamel Product Co.
Cicero, Illinois

LUSTERLITE LEADER
FREE
Monthly Bulletin

~Especially in Enameling The proper is Essential~

Why not send for
a Testing Sample of

LAKE COUNTY CLAY

It Burns White
and
Holds Enamel in Suspension

LAKE COUNTY CLAY CO.

Edgar Plastic Kaolin Co. Edgar Brothers Co.
General Offices
METUCHEN, N. J.

BUYERS' GUIDE (continued)

R

Recorders (CO, CO_2, SO_2 and Draft)
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Recording Instruments
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Reducing Valves
Fisher Governor Co.

Refractories
Corundite Refractories Co.
Harbison Walker Refractories Co.
Norton Co.
The Corborundum Co.
The Exolon Co.
United Clay Mines Corp.

Refractory Materials
Golding Sons Co.
Harbison Walker Refractories Co.
The Exolon Co.
United Clay Mines Corp.

Regulators (Automatic Temperature)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Rutile
Titanium Alloy Mfg. Co.

S

Saggers
Norton Co.
Potters Supply Co.
The Carborundum Co.

Sagger Clay (Georgia)
Golding Sons Company

Sagger Presses
Chambers Brothers Co.
Mueller Machine Co., Inc.

Screens (Cloth, Electric Vibrating)
W. S. Tyler Co.

Screening Machinery
W. S. Tyler Co.

Separators (Inclined Vibrating)
W. S. Tyler Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Roessler & Hasslacher Chemical Co.

Shakers (Testing Sieve)
W. S. Tyler Co.

Sieves (Testing)
W. S. Tyler Co.

Silica (Fused)
The Exolon Co.

Silica Blocks
Eureka Flint & Spar Co.
Golding Sons Co.

Silicon Carbide
The Exolon Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
Harshaw Fuller & Goodwin Co.
Norton Co.
The Exolon Co.

Slabs (Furnace)
Norton Co.
The Carborundum Co.

Smelters
Chicago Vitreous Enamel Product Co.
U. S. Smelting Furnace Co.

Soda Ash
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Sodium Antimonate
Harshaw Fuller & Goodwin Co.
Metal & Thermit Corp.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.

Sodium Fluoride
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Spar
Erwin Feldspar Co.
Golding Sons Co.
Harshaw Fuller & Goodwin Co.
Pennsylvania Pulverizing Co.
Roessler and Hasslacher Chemical Co.

Spurs
Potters Supply Co.

Steam Traps
Fisher Governor Co.

Stilts
Potters Supply Co.

Strainers (Oil, Water)
Fisher Governor Co.

Sulphuric Acid
Drakenfeld & Co., B. F.
Harshaw, Fuller & Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.

RIVER FELDSPAR

Ground to Your Specifications up to 325 mesh.

A High Grade, Uniform, White

POTASH FELDSPAR

THE RIVER FELDSPAR CO., Middletown, Conn.

GEO. E. WORTH, *General Manager*

PENNSYLVANIA SALT MANUFACTURING COMPANY

Executive Offices: Philadelphia, Pa.

Works: Philadelphia and Natrona, Pa., Wyandotte and Menominee, Mich.

Representatives:
New York Chicago
Pittsburgh St. Louis

PENNA. SALT MANUF'G. CO.
PURE
GREENLAND KRYOLITH
PHILADELPHIA, PA

THREE ELEPHANT BORAX

99.5% Pure

We also make Boric Acid, guaranteed 99.5% pure

Write us for specification and price

American Potash-Chemical Corporation

WOOLWORTH BLDG. NEW YORK CITY

"A New Experience in Service"

"If all firms would give such efficient service, it would be a greater pleasure to do business."

An Engineer.

Back Numbers of Periodicals {Bought / Sold

Over 1,000,000 copies of odd numbers in addition to Volumes and Sets in stock regularly

Catalogue sent upon request

The H. W. Wilson Company **New York City**

963 University Ave.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

T

Tachometers
Brown Instrument Co.
Leeds & Northrup Co.

Talc
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Temperature Controls
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Temperature Instruments (Measuring)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermocouples
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermometers (Electric Resistance, Indicating, etc.)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile (Refractory)
The Carborundum Co. (*Carbofrax*)
Harbison Walker Refractories Co.

Tile Machinery (Floor and Wall)
Mueller Machine Co., Inc.

Tin Oxide
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Metal & Thermit Corp.
Roessler and Hasslacher Chemical Co.

Titanium
Harshaw Fuller & Goodwin Co.
Titanium Alloy Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

V

Vacuum Pumps
Mueller Machine Co., Inc.

Valves (Automatic Control)
Brown Instrument Co.
Engelhard, Chas., Inc.

Valves (Reducing, Pressure, Exhaust)
Fisher Governor Co.

V-Notch Meters
Brown Instrument Co.

Vibrating Screens
W. S. Tyler Co.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.
Roessler and Hasslacher Chemical Co.

Wire Cloth
W. S. Tyler Co.

Witherite
Harshaw Fuller & Goodwin Co.
Innis, Speiden & Co.

Woven Wire
W. S. Tyler Co.

Z

Zirconia
Harshaw Fuller & Goodwin Co.
Roessler and Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

PARIS TOP WHITE
JERNIGAN BALL
BLACK & TAN WAD

H. C. SPINKS CLAY CO.

Home Office: 5th and Monmouth Sts., Newport, Ky.
Branch Office: 504 Distributors Bldg., Chicago, Ill.

GOLDING-KEENE COMPANY

KEENE, NEW HAMPSHIRE

FELDSPARS ★★ FLINTS

"Great Stone Face"
Profile Notch,
N. H.

THE STANDARD FLINT & SPAR CORP.

TRENTON, NEW JERSEY

CRANBERRY FELDSPAR

Washed, Dried, Magnetically Separated,
Tube-Mill Finished

Our Mill is Laboratory Controlled

WRITE FOR ANALYSIS AND SAMPLE

United States Feldspar Corporation

Quarry and Mill:
CRANBERRY CREEK
Fulton County, N. Y.

New York Office:
39 BROADWAY

(When writing to advertisers, please mention the JOURNAL)

KENTUCKY-TENNESSEE CLAY CO.

Miners and shippers of uniform, dependable clays whose quality has been proved and established

General Office **- - MAYFIELD, KY.**

CLAY MACHINERY!

SAGGER ROOM	SLIP HOUSE	GRINDING ROOM
Grog Pans	Blungers	Clay Crackers
Pug Mills	Agitators	Pulverizers
Sagger Presses	Lawns	Cage Grinders
Wad Mills	Pumps	Dust Screens
Grog Screens	Filter Presses	Pebble Mills
PRESS ROOM	**GREEN ROOM**	**GLAZE ROOM**
Tile Presses	Jiggers	Glaze Mills
Faience Presses	Pull Downs	Agitators
Porcelain Presses	Cleaning Wheels	Lawns
Dies & Equipment	Batting Machines	Pumps

THE MUELLER MACHINE CO.
TRENTON, N. J.

HIGH GRADE
CLAYS
OF EVERY KIND - FOR EVERY PURPOSE
UNITED CLAY MINES
CORPORATION
GENERAL OFFICES TRENTON, N. J.

"Proctor"

DRYING MACHINERY

for all Clay Products

Electrical Porcelain

Sanitary Ware

General Ware in Molds

Dipped General Ware

Clay Rolls : Spark Plugs

Saggers : Tile

Refractories : Brick

Chemical Stoneware

PROCTOR & SCHWARTZ, INC.
PHILADELPHIA, PA.

(When writing to advertisers, please mention the JOURNAL)

PROFESSIONAL DIRECTORY

T. W. GARVE
Engineering
510 Schultz Bldg., Columbus, Ohio

Remodeling and Design of Plants
Design of Buildings, Machinery,
Dryers, and Kilns
Preliminary Investigations

THE SHARP-SCHURTZ CO.
Chemists for the Ceramic Industry
We have fully equipped laboratories at
Lancaster, Ohio, U. S. A.

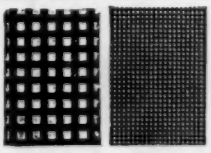
CONSULTING ENGINEERS
Your card in the professional directory places your name before the entire ceramic field.

CLASSIFIED ADVERTISING

Wanted: A research assistant who has had training and practical experience in ceramics. For particulars address C. W. Parmelee, Department of Ceramic Engineering, University of Illinois, Urbana, Illinois.

Man with 20 years' experience casting vitreous china, with thorough knowledge of complete process, seeks position with sanitary manufacturer. Energetic and not afraid of work. Best of reference. Address Box 64-C, American Ceramic Society, 2525 N. High St., Columbus, Ohio.

CERAMIC ENGINEER. Well established manufacturer of ceramic materials desires to broaden present narrow line with aid of young graduate engineer on half or full time. Salary plus traveling expenses and commissions. Work includes consultation service and selling among heavy clay-working plants. Several years' previous experience necessary in production or laboratory. City headquarters within 100 miles of New York. State fully degrees, school, age, marital status, practical experience and salary expected. Strictly confidential. Address Box 65-C, AMERICAN CERAMIC SOCIETY, 2525 N. High St., Columbus, Ohio.



WOVEN WIRE SCREENS
TESTING SIEVES
HUM-MER *Electric* SCREEN

THE
W. S. TYLER
COMPANY

CLEVELAND
OHIO
U. S. A.

TRADE MARK

Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY

(When writing to advertisers, please mention the JOURNAL)

ALPHABETICAL LIST OF ADVERTISERS

	Page
Abbé, Paul O.	36
American Gas Association	4
American Potash-Chemical Corp.	25
American Rolling Mill Co.	2
Brown Instrument Co.	6
Carborundum Co.	5
Chambers Bros. Co.	21
Chicago Vitreous Enamel Product Co.	23
Classified Advertising	30
Consolidated Feldspar Corp.	36
Corundite Refractories, Inc.	33
Drakenfeld & Co., B. F., Inc.	34
Edgar Bros. Co.	23
Engelhard, Charles, Inc.	35
Erwin Feldspar Co.	36
Eureka Flint and Spar Co.	21
Exolon Co.	19
Ferro Enamel Supply Co.	32
Fisher Governor Co.	3
Genesee Feldspar Co., Inc.	23
Golding-Keene Co.	27
Golding Sons Co.	36
Hammill & Gillespie, Inc.	32
Harbison-Walker Refractories Co.	19
Harrop Ceramic Service Co.	36
Harshaw Fuller and Goodwin Co.	8
Hommel, O., Co.	37
Innis, Speiden & Co., Inc.	32
Journal of the Society of Glass Technology	32
Kentucky-Tennessee Clay Co.	28
Lake County Clay Co.	23
Leeds & Northrup Co.	1
McDanel Refractory Porcelain Co.	30
Metal & Thermit Corp.	Outside Back Cover
Montgomery Porcelain Products Co.	21
Mueller Machine Co.	28
National Silica Co.	15
Norton Co.	13
Pacific Coast Borax Co.	19
Pennsylvania Pulverizing Co.	17
Pennsylvania Salt Mfg. Co.	25
Philadelphia Drying Machinery Co.	38
Potters Supply Co.	15
Proctor & Schwartz, Inc.	29
Professional Directory	30
River Feldspar Co.	25
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Spinks, H. C., Clay Co.	26
Standard Flint & Spar Corp.	27
Titanium Alloy Mfg. Co.	Center of Book 10
Tyler, W. S., Co.	30
United Clay Mines Corp.	28
U. S. Feldspar Corp.	27
U. S. Smelting Furnace Co.	11
Vitro Mfg. Co.	17
Wilson, H. W., Co.	25

(When writing to advertisers, please mention the JOURNAL)

Since 1848
Importers of

ENGLISH CHINA CLAYS
ENGLISH BALL CLAYS
CORNWALL STONE
TALC (STEATITE)

Dependable Qualities of Ceramic Materials for all Branches of the Industry

HAMMILL & GILLESPIE, INC.
225 Broadway
New York

1816 CHEMICALS 1929

"Over a Century of Service and Progress"

South Dakota
FELDSPAR

An extremely high-grade Potash Spar ground in our own mills under constant and thorough chemical control.

Capacity up to 300 Tons Daily

We solicit your inquiries

INNIS, SPEIDEN & CO., Inc.
Importers, Manufacturers, Exporters
46 CLIFF STREET NEW YORK

Branches:
BOSTON PHILADELPHIA
CHICAGO CLEVELAND
GLOVERSVILLE

You can buy anything from a complete enamel plant to a pair of asbestos mittens from us and be sure of getting good value and fair treatment.

THE FERRO ENAMEL SUPPLY CO.
Cleveland, Ohio
"Builders of the Best"

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

ANNUAL SUBSCRIPTIONS TO SOCIETY (Including Journal)

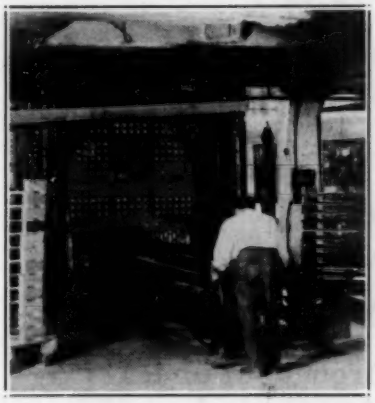
Ordinary Members	$ 7.50
Collective Members	15.00
Price per Number to non-Members	2.50
Price per Volume (unbound) to non-Members	9.00

Forms of application for membership may be obtained from the American Treasurer of the Society, Francis C. Flint, Washington, Pa.

Address orders and inquiries to: The Secretary, Society of Glass Technology, The University, Sheffield, England

(When writing to advertisers, please mention the JOURNAL)

Enamelers Wise... ...use CORUNDITE



Corundite supplies part or all requirements of 47% of the enameling trade.

Certainly, only service and a quality product could make this possible.

So why don't you write for our prices when you are about to build or repair smelters or muffles?

We are glad to help you

Consulting service free

Write for our latest bulletin and prices

CORUNDITE REFRACTORIES, INC.

Formerly Massillon Stone & Firebrick Co.

Since 1882

MASSILLON, OHIO

Established 1869

B. F. DRAKENFELD & CO., Inc.

45-7 Park Place, New York

Pioneer and Premier Producers of
Vitrifiable Colors in America

OXIDE COLORS

FOR ENAMELERS

Manufactured Throughout under
Strict Chemical Control

SPECIAL AND UNIQUE COLOR SHADES

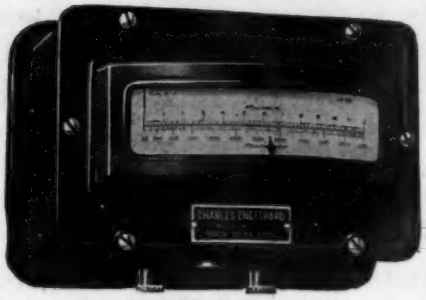
Prepared to Meet Individual
Requirements

Order Direct or through Following Agents

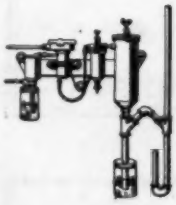
FERRO ENAMEL SUPPLY CO.
CLEVELAND, OHIO

BRAUN CORPORATION
LOS ANGELES, CALIF.

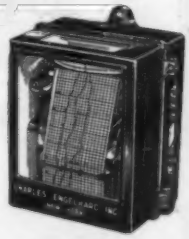
Your *Product* is as good as the instruments you use



Type W 1 Indicator



CO_2 Analyzer



Type S Recorder

In the manufacture of ceramic products draft is important. A good draft in the kiln is produced by a good stack and flue system if the setting of the ware does not throttle the draft. This causes fuel loss due to unburned gas going through to the stack.

If your firemen have an *Engelhard* CO_2 Analyzer, they will know whether the kiln atmosphere is oxidizing or reducing. The percentage of CO_2 tells them how much air is being admitted during the oxidation period. It gives guiding data with which to duplicate previous firings. It enables you to maintain uniformity of product at reduced costs.

As many as 6 analysis units may be connected with multiple *Engelhard* Type S Recorder.

Our CO_2 Recording Analyzer Bulletin will be gladly mailed on request.

CHARLES ENGELHARD, INC.

Standard for 30 Years

90 Chestnut Street, Newark, N. J.

Branches: Boston, New York, Pittsburgh, Cleveland, St. Louis, Montreal, Ottawa, Toronto: R. E. Chase & Co.; Tacoma, Wash.: Queen City Steel Treating Co.; Cincinnati: Jensen Instrument Co., Los Angeles

(When writing to advertisers, please mention the JOURNAL)

We Have Been Producing High Grade Products for 64 Years

FELDSPARS—Mined from our own extensive properties, located in the finest producing centers from Canada to North Carolina, from Maine to South Dakota.

FLINT—Of different well known varieties of assured quality, such as pure imported French Flint; American Rock and Sand Flint.

CLAYS—Secured from our own mines in different localities, including Delaware Kaolin; Georgia China and Sagger Clays; Kentucky Ball and Sagger Clays; and other Clays.

CORNWALL STONE—Hard Purple Rock—The acknowledged standard Imported from England and dry ground at our mills in East Liverpool, Ohio, and Trenton, N. J.

BITSTONE and OTHER RAW MATERIALS.

CONSOLIDATED FELDSPAR CORPORATION
GOLDING SONS COMPANY
ERWIN FELDSPAR COMPANY, INC.
"A Combination for Trade Service"

TRENTON NEW JERSEY

HARROP CERAMIC SERVICE CO.

Engineers and Constructors

Engineering and Laboratory Service COLUMBUS, OHIO

PAUL O. ABBÉ

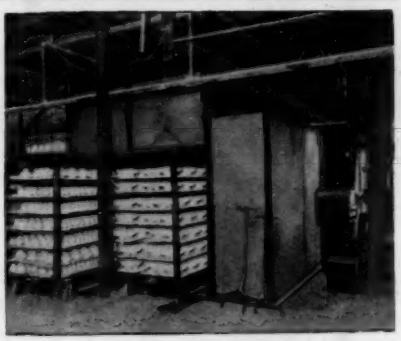
Ball and Pebble Grinding Mills and Mixers

PAUL O. ABBÉ INC.

247 Center Ave.
Little Falls, New Jersey

ANNOUNCING
The New
OPACIFIER
HOMMEL'S
WHITE
OXIDE
Reduces opacifying costs 50%.
Has higher acid-resisting quality.
Works at lower firing temperature.
It is absolutely non-poisonous.
Gives higher gloss.
Does not fluctuate in price.
Is made to your requirements.
You are acquainted with the superior strength of Hommel's colors . . . Red, Black, Blue, Green, etc. Here is a new color, which is revolutionizing the entire enameling industry—
HOMMEL'S WHITE OXIDE
—a material which has at least 50% more covering power than tin oxide.
It is not merely another substitute opacifier for tin oxide. It is a material which is being recognized as
THE OPACIFIER
The O. HOMMEL CO.
209 FOURTH AVE. PITTSBURGH, PA.
New York Office, 19 W. 34th St.
Quality First Since 1891

"HURRICANE"
DRYERS
WIN
by
Comparison



The Vice-President of a large porcelain ware plant writes, *"We have experimented with various types of dryers, and we are convinced that your equipment is the most practical and handles the work better than any that we have ever used."*

"HURRICANE" Dryers are built in Continuous Conveyor, Truck and Tunnel Truck Types, with or without Automatic Control of Temperature and Humidity, and are adapted for all types of ceramic products, including saggers, spark plugs, tile, grinding wheels, enamel ware, etc.

HURRICANE
Ideal Drying Every Day

The Philadelphia Drying Machinery Co.
3351 Stokley St., Philadelphia, Pa.
***New England Office:* 53 State St., Boston, Mass.**
113

A Coöperative Enterprise

Purchasing advertising space in this Journal is reciprocity with those on whom you depend for sale of your product.

This Journal is published by the industrial, technical ceramists who make the decisions regarding materials and equipment to be used. It is not issued for financial profit and the sale of advertising space meets only a portion of the cost of publishing.

Here is your opportunity to help yourself by assisting your customers!

The SOCIETY will pay $1.00 for the following *Journals* and $5.00 for the *Transactions* now out of print.

Journal of the American Ceramic Society

June, 1923
January, 1924
February, 1924
January, 1925
January, 1926
March, 1926
March, 1927
January, 1928

Transactions of the American Ceramic Society

Volume II, 1900
Volume IV, 1902
Volume V, 1903
Volume VI, 1904
Volume VII, 1905
Volume VIII, 1906
Volume IX, 1907
Volume X, 1908
Volume XI, 1909
Volume XII, 1910
Volume XIV, 1912
Volume XV, 1913
Volume XVI, 1914
Volume XVII, 1915
Volume XVIII, 1916
Volume XIX, 1917

Look over your old copies. If you find among your extras any of these listed here, send them to

THE AMERICAN CERAMIC SOCIETY
2525 N. High Street
COLUMBUS, OHIO

(When writing to advertisers, please mention the JOURNAL)

Better Glazes!

Hundreds of firms, including many of the very largest in the country, are definitely committed to the exclusive use in glazes of

M and T
TIN OXIDE

They find that by its use they are assured of glazes that are:

—always a rich pure white

—always free from specks and discolorations

—always remarkably brilliant

Metal & Thermit Corporation

Ceramic Department

Homer F. Staley, Mgr., R. R. Danielson, Director of Research

120 Broadway, New York City

Better Glazes!